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UNITED STATES DEPARTMENT OF AGRICULTURE

FOREST SERVICE

FOREST RESEARCH ACTIVITIES

FOREST MANAGEMENT
WATERSHED MANAGEMENT
FOREST PRODUCTS

FOREST ECONOMICS
RANGE MANAGEMENT
FOREST SURVEY



FEB 1940



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FOREST RESEARCH
BI-MONTHLY REPORT
February 1, 1940

FOREST RESEARCH

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GENERAL

Allegheny

Personnel. Ostrom is on a three months training detail in the office of Forest Measurements in Washington. Mollenhauer has been placed in charge of the Flood Control Surveys for the Northeastern Region and is being assisted by Lippert. MacConnell, former Regional Hydrologist, has transferred to the Weather Bureau, leaving a vacancy in the staff, which is being filled by Morang. Tuthill is now Senior Representative on the Allegheny Flood Control Survey.

Meetings. Shirley presented a paper entitled, "The influence of nutrient balance on the drought resistance of young conifers" before a joint session of Section O of the A.A.A.S., the American Society for Horticultural Science, and the Society of American Foresters in Columbus, Ohio. This paper brought out that the true relationship of a single nutrient element to drought resistance can not be determined without at the same time varying the concentration of other elements. The optimum combination of nitrogen, phosphorus, and potassium was not determined.

Appalachian

Meetings. The Appalachian Section, Society of American Foresters, held its annual winter meeting in Asheville, January 19 and 20. The Committee on the Cumulated Index for the Journal of Forestry reported that all cards necessary to bring the Index up through December 1939 had been completed and that typing of the manuscript will be the next step. E. N. Munns, as guest speaker at the banquet on January 19, gave an informative description of the flood control activities of the U. S. Department of Agriculture.

Central States

Meetings. During the A.A.A.S. meetings in Columbus December 27 to 30, the Society of American Foresters sponsored a two-day program, December 29 and 30. The Central States Section, A. G. Chapman, local program chairman, was responsible for the December 29 papers, abstracts of which will be published in a later issue of the Journal of Forestry.

During early December efforts were applied in cooperation with the State Foresters of Ohio, Indiana, Illinois, Iowa, and Missouri in preparation for the hearing of the Joint Congressional Committee at Madison. Results of tangible importance to the station

are five excellent manuscripts embodying much valuable information pertaining to forestry in the Central Hardwoods Region.

The station is working closely with the State Land Use Planning Committee of Ohio in developing a new system of A.C.P. payments for forestry practices. It is hoped that the plan can be tried out in Ross County and, if the experiment is successful, form a basis for extended action in other states.

A two-day meeting was held at Ohio State University on December 6-7 to discuss the status of county planning. A striking and encouraging feature of the work done in Ohio, to date, is the excellent job of land classification being done by the local County Committee. These committees are definitely picking out all forest land in their counties, going into detail in proximity to good land to a degree unattempted by any federal or state agency. Forestry definitely is a part of their program. An evening meeting provided a review of the state forestry program, and a presentation of the proposed Walsh-Fulmer forest restoration act. The committee refused to approve this proposal, preferring to study it for a while. Nominal charge for use of state forest-parks was proposed and discussed, as a source of added funds for state forestry.

On December 21, an evening meeting of federal agencies with the Ross County Agricultural Planning Committee at Chillicothe, Ohio, considered further and in detail the forestry needs of the Ross County program. The difficulties confronting the hill resident and land owner are linked largely with the forest problem. The committee pointed out the failure of the A.C.P. program to benefit the hill farmer on a par with the corn-producer on flat land.

Kuenzel spoke before the Forester's Conference of the Ohio Woodland Survey December 16 on "Suggested Procedure for a Cull Study on Ohio Hardwoods."

Personnel. Miss Dencyer arrived at the Station on December 9 on detail from the Office of Forest Measurements, Washington, D. C., to take charge of computing work for C.C.C. projects. Miss Jean Kerr of the Washington editorial staff came to the Station on January 8 to edit various manuscripts and papers now in hand. Liming was detailed to Washington for three months beginning January 8 for the purpose of receiving training in statistical methods. In his absence Johnston will carry on his work.

Lake States

Seminar Program. The Station again this winter is continuing its practice of holding a series of seminars, for the purpose of providing an opportunity for the discussion of various subjects with the faculty and graduate students of the Division of Forestry and our own staff.

To date the following subjects have been discussed:

1. Results of Nursery Fertility Studies (Illustrated by Kodachrome slides) by Stoeckeler.
2. Application of Latest Experimental Designs to Forestry Problems by Blythe.
3. Bird's-Eye View of Forest Products Industries in the Lake States by White.
4. Some Food Habits of Chipmunks and Their Probable Effect on the Ecological Succession in the Forest by Aldous.
5. Farm Forestry Research Program for the United States by Eyre.

The meetings have been well attended, with approximately 30 or 40 people present at each seminar.

Meetings. "Labor's Interest in Forestry" was the subject of a paper delivered at the Annual Meeting of the Wisconsin State Council of the United Brotherhood of Carpenters and Joiners of America by the Director of the Station. Zon stressed the fact that although labor, industry, and the general public have much in common in their approach to the forestry problem of the northern Lake States, the woods and mill workers have a much greater stake involved in the early restoration of devastated forests and in a more efficient handling of the remaining forest resources, for their very livelihood depends upon a productive forest managed on a permanent basis. For this reason, he stated, labor should become the most potent force for the inauguration of a far-reaching, aggressive program of forest restoration and forest development.

Northeastern

Personnel. Huberman was recently transferred from the Division of Forest Management Research in Washington to the Station where he has taken over the white pine management project. Bratton transferred to the Station from NETSA in January to take charge of the Connecticut Farm Forestry Research Project.

Meetings. The annual meeting of the Forest Research Council was held at the offices of the Experiment Station December 15 and 16. The meeting was dedicated primarily to discussions of forest products and forest wildlife.

Northern Rocky Mountain

Personnel. I. V. Anderson, chief of the Division of Forest Products since 1935, transferred on January 1 to the position of chief of the Division of Wildlife Management in the regional organization.

FOREST ECONOMICS

FOREST SURVEY

Appalachian

Preliminary plans have been prepared for initiating the Survey in Virginia this spring. Work will be begun in the eastern portion of the state and will be extended through the central Piedmont region as funds permit. It is expected that six 3-man crews will be sent to the field with a temporary field office in Richmond.

The general plan of field work will follow closely that used in other southern states. Lines will be run at 10-mile intervals with sample plots every 10 chains on line. A few changes are being incorporated in the procedure to give more detailed data on forest sites and degree of stocking and to enable a closer coordination between the findings of the Survey and those of the Management Division of the Station.

The first returns from the 1939 Census of forest industries were received in the latter part of January. This project, carried on in cooperation with the Bureau of the Census, has been extended this year to include both North Carolina and South Carolina. The field record of industries will be made by Census agents and the forms then forwarded to this office for editing and checking. With the experience gained in last year's cooperative project, this arrangement should result in a very complete census of forest industries in the two states.

The report for the southern coastal plain of North Carolina (Unit #1) has been returned by the reviewers and the comments and criticisms are being incorporated in a final draft. The report for the northern coastal plain of North Carolina (Unit #2) has been completed in first draft and is being given a Station review prior to submission to the Regional Office, the State Forester, and the Washington Office.

Lake States

Cunningham and Moser attended a meeting of the Forestry Committee of the Michigan Academy of Science in Lansing on January 17, the purpose of the meeting being to advise the Conservation Department on the "rate of closing in of second-growth timber in northern Michigan."

The Michigan Conservation Commission is concerned lest game production will be seriously curtailed as the millions of acres of cut-over land in northern Michigan which have restocked with aspen,

scrub oak, and a few of the more valuable species, crowd out the brush and grass as a result of the increasingly effective fire protection. The Commission requested a report showing actual acreage and conditions of forest types, an estimate of prospective timber yields, and the probably effect of expected developments on fire hazard, game supplies, and economic and social conditions in the wild-land districts of the State.

This discussion brought out that many areas in Michigan are considered more valuable for game than for forest production. Apparently, need is developing for some type of land classification and zoning of forest lands for different purposes. Hitherto, rural zoning in Michigan has been concerned merely with separating agricultural from forest areas.

H. G. White is conducting a resurvey of forest drain in northern Minnesota--five years after the original Forest Survey. The most notable development was the permanent closing of two of the largest sawmills--at International Falls and Cloquet. Some of the other industries have expanded operations since 1934.

Questionnaires from the 1939 Census of Manufactures are being received at the Station for editing in accordance with the recently signed agreement with the Census Bureau. J. A. Diemer is doing the editing.

Pacific Northwest

General. The analytical and report writing steps of the case study of the Cottage Grove working circle were completed late in December. As a result of this study and a companion study made by the Regional Office, Division of State and Private Forestry, recommendations for a regional program directed towards retardation of timber liquidation are being formulated.

Inventory Revision Progress. As a result of the recent extension of Olympic National Park the ownership in Clallam County has changed radically. This is now being adjusted and when the inventory statistics are released for this county they will include up-to-date figures for national forest and national park.

Results of the Reinventory. The past 6 years in Coos County have followed the same general pattern set by other counties in the Douglas fir region. Between 1932 and 1938 saw-timber volume was reduced 2.8 billion board feet, of which 80 percent was Douglas fir. The area of nonrestocked cut-over land, logged prior to 1920,

more than doubled during this period, chiefly the result of the Bandon fire which destroyed a large acreage of second growth.

In Thurston County the total saw-timber volume was reduced a third between 1932 and 1939, leaving only 1.4 billion board feet in the county. The area of nonrestocked cut-over land logged prior to 1920 nearly doubled as a result of fire. About half the area logged from 1920 to 1929, inclusive, had restocked by 1939.

Southern

General. Eldredge and Ineson spent December 12-19 on an inspection trip through the naval stores region, during which time they conferred with a number of industrialists on the forest situation. Eldredge also spent January 14-20 with the Department of Agriculture traveling conference; during this conference discussions were held regarding the weaving of forestry into the agricultural program in the South. During the latter trip, Eldredge gave an address entitled "Forests of the South in Relation to the Agricultural Situation," before the conference and assembled federal and state agricultural workers at Clemson Agricultural College, Clemson College, South Carolina.

Eldredge also prepared an article, entitled "The Hardwoods of the South--An Opportunity for Greater Industrial Development," for Manufacturers Record, which is scheduled to appear in their special issue this spring, which will be called "The South's Resources."

Ineson devoted considerable time to development of the new economics project: the financial structure of the forest industries in the South.

FOREST TAXATION AND INSURANCE

Pacific Northwest

Taxation. Work progressed but slowly on the local government adaption study in the State of Washington.

The hearings for 1940 on the lands proposed for classification under the Oregon yield tax law were held in nine counties. The area of lands proposed for classification was relatively small in each county. Hearings were held in one county in which no lands had

previously been classified but as a result of the hearing it is not certain that lands will be classified in this county. In two of the counties a large land owner continued to register objection to the classification on the grounds that the yield tax was a cloud on the title which might interfere with the lands being transferred to the U. S. Government for forestry purposes. The fact that classified lands in the same counties had, in the past, been accepted by the U. S. Government was known.

Pacific County, Washington, with about 10 billion board feet of timber in private ownership, will have no property tax for county purposes this year, according to the verdict of the State Supreme Court. The county is petitioning for a rehearing. A large timber company filed suit to prohibit the county from levying a property tax, claiming that funds on hand were adequate to balance the budget.

Southern

Field work by Craig on the tax-index project was completed during the bi-monthly period in Quitman and Holmes Counties, Miss.; the former lies entirely in the Delta bottomland hardwood region, while the latter contains three forest type-groups, namely, the short-leaf-loblolly pine-hardwoods upland, the upland hardwoods of the loessial bluffs, and the Delta bottomland hardwoods.

One striking feature noted in Quitman County was the large amount of land clearing which has occurred in the past five years. Statements were made by local residents that owing to the high drainage taxes imposed on land in this county the only economy which would provide for their payment was the production of the maximum yield of cotton on the maximum number of acres per farm. A rough estimate of the forest acreage of the county indicates that since 1932 (the date that the Forest Survey covered the county), the area occupied by some form of forest growth has decreased by as much as 40 percent. There has, of course, been a similar or greater decrease in the volume of standing timber. Extensive reduction in forest area has also been made in many of the other Delta counties in Mississippi.

In Holmes and adjoining counties, oil leasing and drilling is strikingly under way. Oil leases are being obtained on most of the area in this and immediately adjoining counties, subsequent to the development of the Tinsley field near Yazoo City. What effect this will have on forest land valuation for tax purposes remains to be seen.

It is planned to analyze the data obtained in the five counties covered to date, together with that to be obtained in one or two additional counties, in the form of a report on forest taxation in Mississippi to be issued this spring.

NEW PUBLIC DOMAIN

Pacific Northwest

Out of 19 western Washington counties canvassed in January as to the date of latest and next tax foreclosure, 17 have replied. In 1940 was the year of the last foreclosure in one of the 17 counties, 1939 in nine counties, 1938 in five, 1937 in one, and 1936 in one. Plans have been made and the approximate dates given for foreclosures in 1940 by 15 counties; one county reported "no plan for some time" and the remaining county reported date of next foreclosure "unknown." The counties of Washington appear to be getting back into their strides of comparatively regular foreclosures after a series of moratoria during the period 1932 to 1938. This does not mean that each county has foreclosed on all foreclosable lands as of the date given.

The State of Washington, up to January 1, had taken over as State Forests approximately 400,000 acres, of which 80 percent had been forfeited to the counties for unpaid taxes, and has commenced negotiations involving transfer of several hundred thousand additional acres to State ownership, which may be completed before the close of 1940, according to a check made by this office with the State Division of Forestry. It is one of Washington's approaches to the New Public Domain problem which has become broadly serious only within the past decade.

Office conferences were held with officials of both States on State organization for the acquisition and management of tax-forfeited forest lands, and on simplified and improved assessment and tax rolls with particular reference to delinquent tax accounts.

PRIVATE FORESTRY

Allegheny

Anthracite Survey. A problem analysis and generalized working plan have now been completed for this Survey. Working very closely with the four district foresters of Pennsylvania in the anthracite region, Ritter detailed from R-7, has found that 109,000 man-days of emergency labor can be effectively employed to complete physical improvements in a sample area within a short distance of coal mining and other communities where unemployment is acute. Ritter has been assisted by Olexis, and Noonan is working on tax delinquency in

Luzerne and Lehigh Counties. Both these Counties, for the first time in many years, will shortly hold tax sales, which we hope may make possible the eventual establishment of county and community forests on a significant scale.

Allegheny

Farm Woodlots

Farm forest Research projects were prepared for Pennsylvania and New Jersey. The New Jersey project has been submitted to Washington, and the Pennsylvania project probably will be ready for submission soon. Both provide for studies in various phases of marketing products from farm woodlots of this territory.

California

A brief survey of public regulations of industry, made in connection with the Joint Congressional Committee hearings, indicated certain conclusions bearing on forest regulation. The general success of public regulation in various industries is evidenced by the acceptance of controls in many fields and by the widening scope of activities and powers of regulatory bodies.

Certain difficulties are inherent in the regulatory process, however. There is usually more or less intense antagonism between the regulating agency and the industry regulated. The process of regulation divides managerial responsibility and may deter technological improvements. The American doctrine of federalism, dividing control between states and the federal government, often prevents satisfactory regulation. Though trends point toward increased federal control, conservation of natural resources still falls mainly under the police powers of states. Forms of regulation, such as forest regulation, however, require a national approach. The judicial control of regulation, particularly in the rate making process, adds to regulatory difficulties. Long-term results of regulation also may be unexpectedly different from short-term results.

Within these limitations, effective regulation appears possible when certain conditions obtain. There must be a clear definition of the objectives and scope of the proposed regulation. New forms of control should be initiated with careful consideration of methods and possible industry and public reactions. With new forms of regulation services and practices should be controlled first, and prices later, if at all. Price fixing has not proved satisfactory for competitive industries. A well-organized, trained, and financed administrative agency is essential. A

regulatory agency of small size, free of representatives of special interest, appears best. The administrative and legal basis for regulations affecting forests should permit a nation-wide attack on the problem, and at the same time be oriented toward wide variations in local conditions. H. R. Josephson, Associate Forester.

Central States

Farm Woodlands. Data from the Illinois Woodland Survey are being compiled in the office of Forest Measurements in Washington where R. E. Worthington is on detail.

Lake States

Norris-Doxey Act. The Station has received rather hearty response from several of the States relative to the initiation of research proposals under the Norris-Doxey Act. To date, four State proposals have been submitted and two others are being prepared. The following have been submitted, the first three of which have been approved:

1. Michigan - An economic study of utilization and marketing.
2. Wisconsin - A land-use study to compare net returns from using hill land for pasture and for the production of timber.
3. Minnesota - Wood requirements of southeastern and central Minnesota and possibilities of meeting them through better utilization of farm forest products and increased productivity of the farm woods.
4. South Dakota - Improved technique of growing, handling, and planting conifers in South Dakota; aimed particularly at improving shelterbelt planting.

Work on the Michigan project was initiated during January, with Carl Holcomb being assigned to the project. Detailed working plans were developed for a study of market outlets and timber marketing problems in the Fenton Farm Forestry project. A second phase of the project, involving a study of the place of the farm woods in the farm business set-up of various types of farming areas is to be started during February.

Northeastern

Farm Forestry. A grant of \$5000 from Norris-Doxey funds, to be evenly matched by the State of Connecticut, was made in November for a cooperative study of wood products as fuel. The use of hogged wood as fuel for heating in one of the state institutions, service tests of the new Char-Wood Heaters in farm homes, development of economical methods of producing wood for fuel from low grade trees or thinnings, and development of portable charcoal kilns are included in the studies. The possibilities of stimulating the use of wood for producer gas will also be explored.

The heating plant of a building in one of the state institutions has been made available for a demonstration test of the use of hogged wood as fuel. This plant, of 80 h.p. capacity, will be remodeled to burn wood, and the equipment needed will be installed shortly. An automatic stoker is included. Observations are being made of the behaviour and fuel consumption of the plant while still burning soft coal, and heat requirements for the building are being ascertained. Similar observations will be made while burning wood. Although it is common engineering knowledge that wood can be burned satisfactorily, an actual demonstration in this region is needed to stimulate use of wood-burning equipment. This demonstration will also contribute to determination of the economics of wood-burning.

Integrated with the demonstration heating tests, the study of producing, transporting, and hogging of low grade wood will aim to reduce costs all along the line in order to permit wood fuel production at a price less than that of equivalent coal.

Service tests of the Char-Wood Heater are being started. This heater, developed from the slow-combustion Juno (Swedish) stove, was placed on the market this past fall. About thirty heaters have been installed in Connecticut and representative installations will be watched for data on heat production and performance under divergent field conditions and methods of handling.

The development of a portable charcoal kiln offers possibilities for cost reduction through elimination of much movement and handling of the wood before firing. Local markets are now served from Pennsylvania sources, operating by clear cutting. By use of a portable kiln it may be possible to compete with Pennsylvania charcoal and still utilize only low grade materials, thinnings, etc.

A start has been made on a cooperative farm forestry research project in the white pine region of northeastern New York. This will be primarily a study of markets and possible outlets for wood from farm woodlots. Headquarters have been set up at Crown Point, New York.

Pacific Northwest

Cooperation. Metropolitan influences on the use of cut-over and other forest lands in Kitsap County, Washington were observed in the field in December by Mr. Pubols of Washington State College in company with DeVries, in continuation of cooperation in land-use studies with the College and the State Planning Commission. In that county, where rural lands are within relatively easy reach of points of occupation in Seattle, Tacoma, and Bremerton, where climatic conditions are mild and scenery is attractive, there has come in a relatively large rural populace on lands of rough topography and poor soil quality. It is not difficult to justify some of this development on a rural residential basis.

Remedial measures for the treatment of forest land in Coos County, Oregon, being considered by the BAE, were reviewed, and the BAE's land classification report for Clatsop County, Oregon, was commented upon. In both of these endeavors, the subject, conversion of cut-over lands from forest to grazing use, is particularly troublesome to all cooperators.

Southern

A recent study by Reynolds at Crossett, Arkansas, of costs of hauling pulpwood with trucks brings out the effect of different classes of roads upon costs. A total of 34 loads, averaging 1.98 units (4' x 4½' x 8') per load, were timed, and all costs, including wages, supervision, maintenance, fuel, depreciation and interest were computed. The costs for dry weather hauling were segregated for the following 3 classes of roads: ungraded woods roads, graded dirt county roads, and gravel highways. Costs of loading and unloading are fixed, but the cost of hauling varies with the distance and class of road. The following table gives the time required per load and the actual cost per unit without allowance for profit to contractor for hauling pulpwood on the three classes of roads:

Time required per load						Cost per unit (4' x 4½' x 8')			
Load	Unload	Delay	Haul 1 mile round trip			Load and Unload	Haul 1 mile round trip		
			Woods road	Graded dirt road	Gravel high- way		Woods road	Graded dirt road	Gravel high- way
<u>Minutes</u>						<u>Dollars</u>			
44.87	26.61	4.14	22.7	7.9	4.7	.677	.291	.122	.093

FOREST MANAGEMENT RESEARCH

FOREST FIRE PROTECTION

Allegheny

Control

A revised method of appraising forest fire damage in New Jersey has been completed in cooperation with the New Jersey Department of Conservation and Development.

Behavior.

The "All-Region-7" (type S-A) fire danger meter was tested with the past year's fire weather records in south Jersey and was found to forecast correctly for only 56% of the time for woods conditions. A temporary meter, prepared for New Jersey conditions by adjustment of the Appalachian type 3 meter, forecasted correctly 80% of the time. Comparisons of danger ratings with fire occurrence, size, and cost showed that on 54 days, having higher than average danger rating during the spring fire season in south central New Jersey, 63% of the total annual number of fires occurred, 95% of the total acreage was burned, and 82% of the annual expenditures for suppression were made. The R-7 meter will be adjusted for New Jersey conditions and tested for another year.

California

Laboratory and field experiments prior to the past year indicated that, in the absence of wind, variations in rate of spread of surface fires could be correlated with fuel and fuel bed characteristics expressed in terms of fineness and compactness respectively. The wind tunnel experiments described in the October 1 report were designed to determine the manner and extent to which these measures are operative when the wind variable is introduced.

Preliminary analyses have been made of observations on 225 fires burned under varying conditions of fuel compactness, moisture content, and wind velocity. The data clearly indicate that fuel compactness becomes of increased importance in limiting rate of spread when wind velocity is increased.

Observations thus far have been limited to fires in ponderosa pine needle litter fuels under varying degrees of compactness which can readily be obtained experimentally. The next proposed step is

to repeat the wind tunnel experiments with fires in different types of fuels, having different degrees of fineness, shapes, and compositions, to extend the range of compactness to approximate the wide range of conditions encountered in the field.

Shapes of the wind tunnel fires were studied in conjunction with their rates of spread. Preliminary indications are that, under conditions of the experiment, wind alone determines the shape of the burned area. Thus, under any given wind condition, a fire burning slowly because of high moisture content or high fuel compactness has the same shape as a fast spreading fire in a fuel of low moisture content and low degree of compactness. Topography and variations in fuel type are additional controlling variables encountered in the field.

Of more general interest perhaps, are the results of analysis of the influence of wind on forward rate of spread. Analysis of earlier field test fire data in the ponderosa pine type indicated a linear relationship between rate of spread and wind velocity within the range of 0 to 5 miles per hour. A limited number of fires studied in the northern California brush type indicated that wind probably has a curvilinear influence at higher velocities, but limitations of the data precluded drawing such a conclusion.

Rates of spread of the small scale wind tunnel fires demonstrate a definite curvilinear influence of wind velocity over the range 0 to 12 miles per hour for all conditions of fuel moisture and compactness of the fuel bed. The portions of the data in the range 0 to 5 m.p.h. approximate a linear relationship between spread and wind velocity, however, confirming in general the conclusions reached in the earlier study. Curvature does not become critical until velocities above this range are encountered.

If one can accept the premise that wind exerts at least an equal influence on spread of larger fires, and apply it to the early field work which indicated an increased influence with time from start, then the logical conclusion is that the influence of wind on rate of spread of fires in light fuels is greater than proportional to the first power of that variable.--C. C. Buck, Associate Silviculturist.

Central States

A number of studies dealing with the psychology of fire prevention are being undertaken at universities and colleges in the Central States. At Iowa State College, Dean Harold V. Gaskell of the Science Department is interested in a study dealing with the public's reactions to fire prevention posters. Color appeal and

memory responses to fire prevention slogans are being made. At Ohio State University, Dr. H. B. English of the Psychology Department has prepared a scenario "Forest Holiday," with a list of questions to be used in gaining the reactions of Ohio school children to fire prevention educational films.

Lake States

Summary of Seasonal Danger Ratings. The fire study field station at Eagle River, Wisconsin, was closed the first of November, and Ralph Nelson, temporary field assistant in charge, spent the balance of his period of employment in St. Paul working on the data collected. On December 11, Ralph Dickie, Ranger at Large on the Upper Michigan, arrived on detail to assist in compiling and analyzing the 1939 fire-weather records.

To date, summaries of the data for the Lake States national forests and for Michigan and Wisconsin have been completed; also a summary of seasonal danger by forests for 1939 and by years for the Lake States national forests as a whole for 1936-39. The latter shows 1939 to be the worst season in the period covered, with a seasonal rating of 15.6 percent of worst possible as against a 4-year average of 14.4 percent. On the basis of the 4-year average, 1939 rates 136.8 percent; 1936 - 104.2 percent; 1938 - 100.0 percent; and 1937 - 86.8 percent.

Northeastern

Detection. In connection with the rebuilding of the lookout-towers in Massachusetts which were destroyed by the hurricane of 1938, the New England Forest Emergency Project is planning to make an analysis of the detection needs of that state. Because of our experience in making similar studies in the past in other states, the Station has been requested to furnish the necessary technical supervision. Stickel has had several conferences with the Division of Fire Control of the N.E.F.E. and has assisted in the preparation of a work plan and in training the men who will do the actual seen-area map. The work will be conducted at one of the hazard reduction camps of the N.E.F.E. in Massachusetts by enrollees who happen to be forest school graduates. It is planned to complete the study by May 1.

Forest-Fire Damage. A progress report on a study concerned with developing tables of standard forest-fire damage values for the Northeastern region has been completed by Stickel and circulated to state foresters in the region and to all eastern forest experiment stations. Although the basic data are insufficient to give trustworthy

FOREST FIRE PROTECTION (cont'd)

figures for regional tables, the study has shown that considerable variation in damage by fire occurs in stands of different size classes and that these damages exceed the estimates submitted by fire wardens by appreciable amounts.

The following table summarizes the monetary losses per acre in the types for which the largest amount of basic data are available.

Northeastern Oak Region	Sawtimber Loss	Cordwood Loss	Repro- duction Damage	Total per Acre
Softwood Cordwood Stands	289 bd.ft. at \$5.00 per M ft. b.m. \$1.44	3.22 cords at \$0.75 per cord \$2.41	\$0.50	\$4.35
Hardwood Stands Less than Cordwood Size	125 bd. ft. at \$5.00 per M ft. b.m. \$0.62	1.90 cords at \$0.75 per cord \$1.42	\$0.50	\$2.54
Hardwood Cordwood Stands	263 bd.ft. at \$5.00 per M ft. b.m. \$1.32	2.27 cords at \$0.75 per cord \$1.70	\$0.50	\$3.52

Since the field work was done entirely in Connecticut and New York, it was possible to make a direct check between the above damage figures and the estimates turned in by the fire wardens by referring to the area and damage figures for the years in which the fires occurred. Considering only that portion of the reported damage per acre that relates directly to timber and reproduction, it was found that the figures in the above table were on the average 2.4 times as great as the damages reported by the states. Even when the total reported losses per acre (i.e. timber plus reproduction plus improvement damage) were compared to the figures obtained in the study, they were less in all cases as far as New York was concerned while in Connecticut only the damage figure for hardwood stands less than cordwood size was smaller than the average total reported damage for that state.

Pacific Northwest

The "Working Plan for the Determination of the Standards and Specifications of Adequate Fire Control on Private Forest Lands of the Douglas Fir Region" was completed and the analysis of the fire records of Snohomish County, Washington, which is the first sample area to be studied, was continued.

Southern

An alinement chart was prepared for estimating discovery time in the longleaf-slash pine type. The axes of this chart are:

Rate of Spread Index
Visibility Distance divided by Distance from Tower
Discovery Time in Minutes

A brief report on this study has been released as Occasional Paper No. 88 and includes the alinement chart. The average of 43 independent first discoveries was 6.93 minutes whereas the average of 86 independent (first and second) discoveries was 8.66 minutes. The chart does not estimate discovery time for less than 6.3 minutes because values in this range were so erratic.

A guide for dispatchers submitted to the Alabama National Forest in the fall was revised as suggested by the National Forest staff. As it now stands, it is 2 alinement charts. The first estimates perimeter at arrival from rate-of-spread index and estimated time from origin to arrival. The second estimates the number of men required to control the fire in thirty minutes from perimeter at arrival and rate-of-spread index. It has been suggested by the Alabama National Forest that this be revised to provide a sliding scale of control time and to reduce it to one alinement chart.

FOREST GENETICS

California

Breeding

The Institute of Forest Genetics now has eight trees which are hybrids between Jeffrey pine (P. jeffreyi) and ponderosa pine (P. ponderosa). These trees were obtained from a small test made in 1931. They are now 8 years old from seed.

Although the data are meagre, it may be stated tentatively that the hybrids are intermediate between the parental species in vigor. Judging by the results of the cross between P. attenuata and P. radiata (in which frost-hardiness is intermediate) it is probable that the hybrids will be intermediate in frost-hardiness also. The practical application of such results is that hybridization provides a means of transferring the greater hereditary vigor of low-elevation ponderosa pines to higher elevations.

Although the hybrids have not produced flowers, the cross is known to be fertile and is probably highly so, since a wild seed-tree of hybrid nature -- the species cross naturally -- was represented by a progeny in the 1929 progeny test. The hybrid nature of the seed-tree was indicated by the fact that some of the progeny resembled Jeffrey pine, while others resembled ponderosa pine.

Although the cross occurs naturally, it is doubtful that the natural hybrids which have been discovered can be assigned to their actual generation. Thus it might be difficult to determine whether or not a natural hybrid is actually an F1 hybrid. It might be a member of the F2, or some subsequent generation. The trees under discussion may be the only known F1 hybrids between those species.

The inheritance of several characters can be established by this cross. Thus, the pitchy nature of the buds of the ponderosa pine pollen-parent is dominant. The color of the foliage is intermediate, and the pubescence on stem of the Jeffrey pine seed-parent is recessive.-- F. I. Richter, Conservationist.

Physiology. In order to determine the influence on the development of ponderosa pine seedlings of soils from three transect nurseries located at elevations of 830, 2750 and 5600 feet, seeds of lot No. 3639 were sown at Berkeley on March 24, 1939, in three 12-inch clay pots. Each pot contained a soil core 12 inches deep taken from one of the three different nurseries. The germinated seedlings were allowed to grow in the pots in the Berkeley greenhouse for three months. The pots were then removed outside and thinned to 19 seedlings in each pot. On September 21 the seedlings were photographed, measured and harvested.

The results of the experiment are shown in the accompanying tables.

Table 1.

Transect Nursery	Elevation	Germination	Average height
	<u>Feet</u>	<u>Percent</u>	<u>Inches</u>
Bassi	830	63	5.10
Institute	2750	57	3.50
Pyramid	5600	23	5.51

From this table it is seen that the best growth took place in the soil taken from the highest transect nursery and the poorest in the soil taken from the nursery of intermediate elevation. The fact that soil fertility at the three nurseries varied should be taken into consideration in interpreting the growth of seedlings at the three localities.

Table 2.

Transect Nursery	Average fresh weight of seedlings	Average dry weight of seedlings	Water content (loss in drying)	Ash Percent of dry weight
	<u>Grams</u>	<u>Grams</u>	<u>Percent</u>	
Bassi	4.400	1.915	56.41	5.177
Institute	2.000	1.263	36.85	4.048
Pyramid	5.000	2.394	55.67	3.628

Table 2 shows that the production of vegetative matter was highest in seedlings grown in soil from the Pyramid nursery and lowest in soil from the Institute nursery.

The ash was further analyzed and the results are given in Table 3:

Table 3.

Transect Nursery	Calcium as Ca O	Magnesium as Mg O	Potassium as K ₂ O	Phosphorus as P ₂ O ₅
	<u>Parts per million</u>			
Bassi	6912	8585	6026	6470
Institute	4471	5206	3652	4321
Pyramid	4485	2865	5231	5791

Nitrogen contents of the seedlings will be reported later.--
N. T. Mirov, Silviculturist.

Needle Studies: The Grey Pines of California. Needle study has assumed considerable importance in systematic identification of hybrid pine seedlings. It now appears possible, however, that the morphology of the stomata may replace the needle cross-section as the systematic criterion. Needle cross-section seems sometimes to have as much variation within a species as between species. On the other hand, stomatal characters seem quite constant for each species. Foliage color is dependent to a great degree on the amount and distribution of white waxy bloom and this bloom is found in the longitudinal rows of stomatal pits. It may be confined to the pits or may occur as a narrow band in which the pits appear to be set.

Digger pine (P. sabiniana) is often called the grey pine. There are, however, three other hard pines of California whose foliage has a distinctly grey cast, namely Coulter pine (P. coulteri), Torrey pine (P. torreyana) and Jeffrey pine (P. jeffreyi). All four are adapted to dry habitats.

To the unaided eye or even under a hand lens there is little to explain why the foliage of these species appears grey while other pines such as ponderosa appear green. At a magnification of 50 diameters or more, however, one may see interspecific differences among the grey pines as well as differences between the grey pines and other pines.

Digger pine needles, for instance, have large square or rectangular stomata densely packed with white wax and occupying a considerable portion of the surface area of the leaf. The epidermis is thick and rather dull and the chlorophyll is light green. These conditions are reflected in the pale grey-green foliage so characteristic of digger pine.

In Coulter pine the size and shape of the stomata, and the amount and distribution of bloom is much the same as in digger pine, yet the general color is a much brighter green. This is due principally to the more transparent epidermis and the deep, brilliant green of the chlorophyll.

Torrey pine has stomatal pits with rounded corners and the area occupied by bloom is less than that of Coulter pine but the pale green surface between stomata makes this species almost as grey as digger pine.

Jeffrey pine needles have more surface covered by wax than any other of this group, the bloom occupying narrow longitudinal bands in which the stomata appear to be set. These stripes of continuous bloom are thin, however, and the brilliant green chlorophyll shadows through, making this species less grey than either digger pine or Torrey pine. This structure, however, makes Jeffrey pine stand out without a possibility of the confusion with ponderosa pine which has troubled even professional botanists on other bases. In young trees the distinction is obvious. Even in needles from old Jeffrey pines, however, under 50 x magnification, the round stoma has a dark center, causing the whitish outside ring to stand out like a sugared doughnut. In ponderosa pine, on the contrary, there are no longitudinal waxy bands on the leaves, and the stomata have whitish centers while the outside is darker and the "sugared doughnut" appearance vanishes.

In the green pines such as ponderosa the stomata, while as numerous as those of the grey pines, are small, round and occupy smaller surface area. They have thus less effect on the general appearance of the foliage.-- Palmer Stockwell, Conservationist.

Northeastern

Controlled Breeding.--The seed harvested from controlled breeding carried on in the spring of 1939 has now been counted and either planted or stratified. The total number of seeds derived from many hundreds of crosses in each of four important hardwood genera is listed below.

Genus	Number of Seed Harvested from				
	Unpollinated control	Self-pollinated	Intra-specific pollination	Inter-specific pollination	Inter-generic pollination
<i>Betula</i>	57,000	25,000	32,000	99,600	12,700
<i>Fraxinus</i>	8	---	1,120	1,300	---
<i>Tilia</i>	4	77	13	114	---
<i>Quercus</i>	1	0	6	9	---

The breeding work with *Betula* included the following species as female parents: *Betula papyrifera*, *B. lenta*, *B. populifolia*; and the following species as male parents: *B. papyrifera*, *B. populifolia*, *B. lenta*, *B. nigra*, and *B. lutea*. Since previous work with this genus indicated the occurrence of parthenocarpy and possibly of parthenogenesis in birch species, many bagged branches bearing female catkins were left without pollination for the production of parthenocarpic fruit. If viable seed is produced in catkins which were fully protected from natural pollination, it will indicate the occurrence of parthenogenesis. Although selfing as well as intra-specific, inter-specific, and inter-generic crosses on *Botula* produced large quantities of fruit, much of this is undoubtedly parthenocarpic in origin and possibly contains parthenogenetic seed. The inter-generic crosses on these species were made with pollen of *Ostrya virginiana* and *Carpinus caroliniana*, two species which bloom at the same time as the birches.

Many thousands of flowers were worked in the genus *Quercus*, but the resulting seed crop, as in previous years, has been very slight. A single acorn was set to unpollinated controls, but this did not appear to be normally developed and may not germinate. Absolutely no seed was set to self-pollination, and only six and nine seeds respectively were set to intra- and inter-specific pollinations respectively. No inter-generic crosses were attempted.

Fraxinus produced some fruit on unpollinated controls, but these apparently parthenocarpic fruits do not appear to be filled and will probably not be viable. A total of 1120 seeds were set

to crosses between members of the same species and approximately 1300 to inter-specific hybridization. No inter-generic pollinations were attempted.

On Tilia 77 seeds were matured to self-pollination, 13 to intra-specific and 114 to inter-specific cross-pollinations. Four seeds were set on unpollinated controls, but in the past such seed has not been viable.

Cytology.--The planning of breeding work and the interpretation of results are greatly facilitated if the chromosome numbers of the parent trees are known. The genus Quercus, with which extensive breeding work is under way, has been found by most cytologists to contain only 24-chromosome (diploid) species. However, work by Friesner (1) and Aufderheide (2) suggested that there might be species with a diploid number of 12. A more recent paper by Natividade (3) reported secondary pairing in several oak species, thus adding strength to the supposition that oaks with a diploid number of 12 might be found.

Somatic chromosome numbers were determined for 19 species of American and European oaks of present or potential importance in breeding in the Northeast. In all species, including several previously reported as having 12 chromosomes in somatic tissues, the somatic number was found to be 24. Thus Quercus may still be considered a homoploid genus.

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1. Friesner, R. O. Chromosome numbers in ten species of Quercus with some remarks on the contributions of cytology to taxonomy. Butler Univ., Bot. Stud., 1:77-103. 1930.
 2. Aufderheide, H. Chromosome numbers in Fagus grandifolia and Quercus virginiana. Butler Univ., Bot. Stud., 2:45-52. 1931.
 3. Natividade, J. V. Investigações citológicas nalgumas espécies e híbridos do género Quercus. Separata das Publicações da Direcção Geral dos Serviços Florestais e Aquícolas, 4:74. 1937. (Abstracts, 7:433. 1937)

Physiology. It has been reported that, in some cases, pollen which has become apparently non-viable following storage may be restored to germinability by humidification treatments.

Preliminary humidification experiments with pollen of Pinus strobus L. and P. resinosa Ait. stored for six months at low humidities have demonstrated a striking restoration of germinability. These experiments have also shown that the two species respond quite differently to storage temperatures, suggesting that there is a fundamental physiological difference between the pollens of these species.

Vegetative Propagation.--The work on vegetative propagation during 1939, involving the use of growth-promoting substances to promote rooting of greenwood cuttings, has been summarized. The results of previous years with hardwood species, including white birch, red maple, and yellow birch, were substantiated. An experiment designed to test the variability of response to treatment with growth-promoting substances in red maple clones indicated that this is apparently an inherent characteristic. The average rooting of cuttings from different individual trees varied from 18 percent to 98 percent. This has been reported in Technical Note No. 29.

MENSURATION

Central States

Attention has been called to a problem in converting factors on the two national forests in Missouri. Brisk demand for white oak staves and header stock for tight cooperage has resulted in accelerated timber sales. Staves are cut from bolts 39 inches long, header stock from bolts 23 inches long. Local usage dictates purchase of bolts on a basis of the "standard" cord (10 feet long), the short cord (8 feet long), or a scale of the total "chord-feet" (the chord measure of heartwood in each bolt). The question of board feet equivalents for these two cord measures and for a cord-foot are pertinent in order to realize sufficient stumpage value from stave sales to meet stumpage for the same white oak volume in log form. Only clear material of highest quality is acceptable for staves. The Station is cooperating with the Mark Twain National Forest in the design of plans and forms for collecting data for analysis to solve this problem.

The work of editing the report on the growth and yield of plantation black walnut was initiated in January. The revision of the report on the development of black walnut was undertaken, after many interruptions, and some progress was made.

Northeastern

Field work on the survey and type mapping of the white pine region in southwestern Maine, which was being done by the CCC, was suspended during the past summer due to press of insect control work. Sufficient data have been accumulated during the three years of active survey to give adequate direction to the national survey when it starts in this region. Meanwhile, information of value in the silvical control of gypsy moth will be extracted from the data.

Pacific Northwest

Permanent Growth Study Plots in Second-Growth Douglas Fir.

Basic computations of the data resulting from last fall's remeasurements of seven Wind River and three Mt. Hood permanent sample plots were completed during the past two months. An analysis of the trend toward normality, based on all remeasurements of the Station's plots, was started in January to define growth tendencies in non-normal stands. Initial computations indicate, as was anticipated, that stocking and age have significant and important effect upon approach to normal. Site quality appears to have slight influence in this regard.

Statistical Analysis, Planting Stock Mortality. First season results of the randomized block experiment, testing effect of Dowax treatment on Douglas fir planting stock show a 51 percent mortality of treated stock versus 38 percent mortality of untreated. Statistical analysis reveals that the difference in survival is significant at odds of 20 to 1, but not at 100 to 1. Analysis of results of a similar but more comprehensive experiment, testing effect of age-class of planting stock as well as Dowax treatment on survival of ponderosa pine at Pringle Falls was nearly completed.

Stand Improvement. Computations of the 1939 remeasurement data on ten Douglas fir thinning study plots at Wind River were completed and the report prepared on the white pine liberation plot established in 1926. The report shows that the white pine has been materially benefited by the liberation, but probably not in proportion to the cost involved. Computations on the seven new thinning study plots in Douglas fir on the Panther Creek piling sale area are nearing completion.

Kachin visited the Columbia and Willamette National Forests, giving field instruction to CCC foremen and enrollees on Douglas fir pruning projects, and initiated a time study of pruning on the latter forest.

REGENERATION

"Glycerine has been turned to practical use in saving millions of young tomato and cabbage plants from dying in shipment through drying out of their roots. The method was worked out by Dr. R. N. DuPuis, industrial chemist of Chicago. Tomato and cabbage plants are grown in the South and shipped North by millions, their roots packed in moist sphagnum moss. It occurred to Dr. DuPuis to substitute a glycerine solution for the plain water, so that if the moss pack dried out there would still be a protecting layer of glycerine over the roots. Large-scale experiments gave encouraging results, and last season the method received a full-scale commercial workout. More than 75 million plants were shipped with glycerine-solution protection." (Science Vol. 90, No. 2348, December 29, 1939.)

The Stations which assisted in the collection of tree seeds for the Institute of Botany at Quito, Ecuador, will be interested in the following letter of appreciation:

PAN AMERICAN UNION
Washington, D.C.

February 10, 1940.

Mr. C. M. Granger, Acting Chief,
Forest Service,
U. S. Department of Agriculture,
Washington, D. C.

Dear Mr. Granger:

We wish to acknowledge receipt of your kind letter of February 8, and of a package containing twenty-eight sample wood blocks and eighty-eight packets of tree seeds, which reached us by messenger. This material has already been forwarded to Mr. Francisco Banda, Consul General of Ecuador in New Orleans, for transshipment to the Institute of Botany at Quito, Ecuador.

This valuable contribution of the Forest Service to the permanent exhibit to be held at the above Institute is greatly appreciated indeed.

Very truly yours,
/s/

J. L. COLOM,
Chief, Division of Agricultural
Cooperation.

JLC/pk

Appalachian

Planting in the Spruce-fir Type. A recent examination of experimental planting plots in the spruce-fir type of the Southern Appalachians has yielded definite information regarding species which may be expected to succeed in this type. During the nine years from 1923 through 1931, 20 species of conifers were planted in 78 plots of 100 trees each near Mt. Mitchell. The general success of the various species, based on survival and growth, is as follows:

Southern balsam fir	-- very good (best).
Red spruce	-- good.
Norway spruce	-- good.
Red pine	-- good.
Pitch pine	-- fair survival and growth, poor form.
Scotch pine	-- fair survival and growth, poor form.
Northern white cedar	-- poor to fair survival, slow growth, good form.
White spruce	-- failure.
Douglas fir	-- failure.
Western white pine	-- failure.
European silver fir	-- failure.
Japanese red pine	-- failure.
Japanese larch	-- failure.
European larch	-- failure.
Lodgepole pine	-- failure.
Japanese black pine	-- failure.
Engleman spruce	-- failure.
Sitka spruce	-- failure.
White fir	-- failure.
Western white cedar	-- failure.

Even the plots which failed, however, usually have a few living trees and it is, indeed, interesting to find such species as Douglas fir, white spruce, lodgepole pine, and European silver fir growing on the slopes of Mt. Mitchell. Some of these trees will probably continue to survive in a stunted condition for many years.

Of 20 species, southern balsam fir, red spruce, red pine, and Norway spruce appear best suited for reforestation programs in the Southern Appalachian spruce-fir type. It is noteworthy that two of these four species are native to the type and a third, red pine, is in general indigenous to regions with a similar climate. Of the remaining 17 species, all exotics, only one, Norway spruce, found a favorable environment in the type.

Southern balsam fir showed the best survival and growth of all species, but its wide use in large-scale reforestation programs

for timber production is questionable because of limited market outlets and its comparatively poor quality as lumber. In spite of these drawbacks, however, it should have a real place in plantings where recreational and watershed protection values are of primary consideration.

California

Cutworm Damage to Seedlings in California Pine Stands. Cutworms, Noctuidae larvae, 1/ frequently cause serious damage to natural and planted seedlings in the California pine region. Observations during several years in California and reports from other regions suggest that these insects contribute to frequent failures of plantations and natural reproduction. Careful study of these insects with a view to their control seems justifiable.

In the western white pine type Haig^{2/} found losses caused by cutworms as high as 26 percent of the total germination of a species in a particular site. Isaac^{3/} reported losses of Douglas fir seedlings from cutworms but did not separate cutworm loss from that of other biotic agencies.

In California, most serious damage occurs to seedlings for one or two months after germination, although some injury to planted nursery stock also has been noted. The larvae, night feeders, are found about one inch under the soil, usually in the immediate vicinity of recently eaten or partly eaten seedlings.

The extent of the damage is indicated by a summary of the losses caused by insects for a five-year period in five study areas, representing cut-over and virgin sites in the ponderosa pine and sugar pine - white fir types in the Stanislaus National Forest.

1/ Specimens have been identified as Euxoa excellans infelix (Sm) by the Division of Forest Entomology, Bureau of Entomology and Plant Quarantine, 336 Giannini Hall, Berkeley, California.

2/ Haig, Irvine T. Factors controlling initial establishment of western white pine and associated species. Yale University, School of Forestry Bulletin No. 41. 1936.

3/ Isaac, Leo A. Factors affecting establishment of Douglas fir seedlings. U. S. D. A. Circular No. 486. 1938.

Table 1. Summary of seedling losses caused by cutworms.

	Incense cedar	Sugar pine	Ponderosa pine	White fir	Total
Total germinated	2314	1536	3054	511	7415
Percent killed	52.9	7.9	28.6	34.4	32.3

The losses in the sugar pine - white fir type, north slope, were significantly higher in cut-over stands than in virgin timber. Losses in the cut-over sugar pine - white fir type also were higher than in the ponderosa pine type, south slope, both cut-over and virgin stands. The differences in losses between species were significant. Differences between years were unimportant.

Cutworm damage also was revealed by examinations of seed spots in northern California brushfield plantations. In 2100 seed spots each of ponderosa pine and Jeffrey pine, all seedlings in 45.8 percent of the ponderosa pine spots and in 7.5 percent of the Jeffrey pine spots were killed by cutworms. In addition, some of the seedlings in 22.7 percent of the ponderosa pine spots and in 32.4 percent of the Jeffrey pine spots, were killed by cutworms.

In the Burgess Spring seedling experiment, 4/ records of about 5600 ponderosa pine and Jeffrey pine seedlings show that 18.6 percent of the ponderosa seedlings and 20.4 percent of the Jeffrey pine seedlings were destroyed by cutworms.

The importance of cutworms as a factor in regeneration may be appreciated by a comparison with the losses from other causes. In the Stanislaus areas the insects killed more seedlings than any other agency; they were responsible for 44 percent of the losses. In the Burgess Spring area, cut-worms killed only half as many seedlings as died from drought, but still were responsible for 21 percent of the mortality.

Selective feeding by the insects may have an important influence on the species composition of mixed stands. In the Stanislaus locations, where several species were available, incense cedar and white fir seedlings were eaten most frequently.-- H. A. Fowells, Assistant Silviculturist.

4/ Lloyd, L. D. Field study of germination and mortality of Jeffrey and ponderosa pine seedlings at Burgess Spring Experimental Range. California Forest and Range Experiment Station office report. 1937.

Central States

In a manuscript ready for the press, describing the outcome of investigations on young shortleaf pine seedlings in high and low pH and high and low soluble calcium soils, it has been pointed out that: (1) Culture media which have an approximate pH value of 6.5 and above, a soluble calcium content of approximately 500 parts per million and above, or both high pH and high soluble calcium contents are toxic to germinating seed and seedlings; these are evidenced by observations upon behavior of greenhouse cultures and shortleaf pine nursery beds; (2) the osmotic pressures of the culture solutions and the alkaline nursery soil solution were not sufficiently high to effect plasmolysis of the seedling root cells; and (3) the expressed sap of the seedling roots was more highly buffered against an acid than against an alkali. The sap from roots developed in an acid soil was more highly buffered against the alkali than was that from roots developed in an alkaline soil. Buffering of the cell sap of roots may be somewhat increased by application of phosphorus to soils low in the element. The pH values of expressed root saps were lower in all instances than those of the soil media in which the roots developed.

Possible effects of high soluble calcium in culture media on the root cells have been briefly discussed.

Lake States

Direct Seeding of Jack Pine. A direct-seeding experiment initiated in the spring of 1937 by the Nicolet National Forest has demonstrated that jack pine may be sown successfully under field conditions in open sand plains having a permanent water table at a depth of $1\frac{1}{2}$ to 5 feet below the surface.

The seeding was made on a 123-acre plot in the Nicolet National Forest located in northeastern Wisconsin. The site, a slightly undulating outwash sand plain underlain by a water table at a depth ranging from 2 to 12 feet, had been plowed the previous August.

The stocking obtained on areas having a permanent water table within $1\frac{1}{2}$ to 5 feet of the surface ranged from 800 to 8,200 seedlings per acre, averaging about 4,500 per acre at the end of the second season after sowing. A partial stand ranging from 300 to 800 trees per acre was obtained on areas with the water table deeper than $5\frac{1}{2}$ feet. The tree percents for the two types of site, based on the ratio of seedling stand at the end of the second year to the number of viable seed sown, were 7.7 and 0.9 percent respectively.

The increase in the stand of seedlings on the areas having a shallow water table is due to the capillary rise of moisture from the water table, which increases the moisture content of the soil within the root zone of the trees and also reduces to some extent the usual heavy mortality due to heat injury during the first year.

Red Pine Seed Storage Tests. Preliminary results from tests now being made by Roe indicate that red pine seed can be kept for at least 12 years without serious loss in germination. Samples of seed from the 1927 crop on the Chippewa (original germination 57.1 percent) and from the 1928 crop in northern Wisconsin (germination 93.0 percent) were dried over sulphuric acid of such concentration as to produce relative humidities from 10 to 40 percent and then stored sealed in various chambers and storerooms on the University Farm Campus.

Although germination is not yet complete it appears that very little loss in viability has resulted from storage in a cold room (32-39° F.), the 1928 seed now averaging better than 84 percent and the 1927 seed 47 percent. On the other hand, seed kept in an underground cellar fluctuating from 32° to 68° F. shows an average of 38 percent for the 1928 and only 16 percent for the 1927 seed, and seed stored in an unheated loft (26-105° F.), 25 percent and 9 percent respectively.

No definite statement can yet be made as to the effect of initial moisture content, although there seems to be a tendency for viability to decrease as the moisture content increases, particularly in the storage at the higher and more fluctuating temperatures.

Relation of Size of Stock to the Subsequent Release Costs. Studies under way with white spruce on the Chippewa National Forest shed some light on the problem of the number of release operations necessary in the establishment of a plantation.

Experiments with 2-2 and 2-0 white spruce have indicated that stock of various sizes respond differently to releasing (see the table). The larger transplant stock shows a greater height growth and better survival with an increasing number of releases. On the other hand, the 2-0 stock shows a decrease in survival with an increased number of release operations, and the height growth shows little advantage with more than two releases.

The reasons for these different reactions apparently are due to differences in the response to drought conditions. Large, well-developed transplant stock was able to withstand these conditions even though opened up by release, whereas the smaller, less sturdy 2-0 stock was injured by exposure.

REGENERATION (cont'd)

For the kinds of stock tested, the best recommendations would seem to be to make releases the first and fourth years following planting in heavy brush, or the second and fourth years on the more open sites. The transplant stock will require no further release but the seedling stock will probably require one more release in the sixth year.

The extra cost of this additional release will probably more than offset the lower initial cost of using 2-0 stock, and furthermore, the survival and height growth will not be as satisfactory as for the 2-2 stock.

Years released following planting	2-2		2-0	
	Survival	Height	Survival	Height
	<u>Percent</u>	<u>Feet</u>	<u>Percent</u>	<u>Feet</u>
1st, 2d, 3d, 4th	58.0	4.6	21.4	2.5
1st, 3d, 5th	57.0	4.2	32.6	2.7
1st, 4th	60.9	3.7	38.9	2.9
3d	46.3	2.9	49.1	2.4
Average	57.2	4.1	30.0	2.6

Northeastern

Plantings in New York State were subjected to extreme drought conditions during the past summer. Water levels reached their lowest point in years and the acuteness of the water shortage is reflected by drying up of wells and springs never dry before. High mortality in plantings on the Chenango Experimental Forest resulted. Plantings of Japanese red pine and Chinese elm showed very high resistance to drought.

Two areas were established for general testing of individual tree response (as against stand response) over periods of short duration (5-10 yrs). As designed, each lot tested will embrace all site variations within the area and the influence of site variations can be segregated. Tests of the field response of white pine raised at different seed-bed densities, species adaptation tests, and tests of hardwood establishment methods have been installed. Exploratory tests of root proliferation of hardwoods to aid establishment, and exploratory white pine grading classes are included.

Rocky Mountain

Soil moisture and drought. The fluctuations in the soil moisture have been studied on the Nebraska National Forest during the last two years. Readings have been taken with Livingstone soil point cones at depths of 6", 18", and 30" on a north and south slope. 1938 was a relatively wet year except for a dry period from October to the end of the year. 1939 had slightly above normal precipitation until the middle of July and from then a progressive deficiency to the end of the season. Nevertheless these comparatively mild drought periods sufficed to bring the soil moisture to the wilting point at depth of at least 30 inches. This indicates that on the sites tested in the sand hills no appreciable amount of moisture within the reach of newly planted trees is carried over a drought of two or more months' duration.

Southern

During December and January three applications of experimental technique that were new to the project were worked out.

One application was the outcome of a discussion about the quality of the soil, and the efficiency of the fertilizer practice, in two southern pine nurseries receiving federal aid. The discussion originated from the somewhat unsatisfactory appearance of stock from the nurseries in question, and from reports of unsatisfactory survival. Ultimately a cooperative test was arranged in which the two nurseries and three others shipped each other 400 seedlings apiece, and each nursery planted on typical sites four balanced, randomized blocks, each block consisting of a 100-tree unit of each of the five nursery sources. The proposed analysis of variance is as follows:

	<u>Degree of Freedom</u>
Locality of planting	4
Nursery of origin	4
Block	15
Interaction, locality x origin	<u>16</u>
Remainder (for error)	<u>60</u>
Total	99

The study is designed to show not only the quality of stock from the various nurseries, but also the relative influences of nursery soil quality and of quality of planting site upon survival. This approach was chosen because it was realized that the characteristic sites to which the stock from each nursery was shipped, rather

than the shortcomings of the nursery soil or its management, might be responsible for the failures of the plantations.

The second new application of technique was developed in a study of initial survival of planted stock on the Palustris Experimental Forest. For the past five years survival studies involving replications of treatments on four balanced, randomized blocks have presented difficulties of interpretation through the location of all four blocks contiguously on one general soil type. In a new approach to this problem 18 treatments were tried with two species (longleaf and slash pine) in a manner to show the relative importance of planting site and of treatment of stock. Of the 18 treatments, 6 were treatments indicated by theory or past studies as likely to give distinctly superior survival; 6 were likely to give about average survival; and 6 were likely to give survival well below average. These were replicated 6 times, not on adjacent blocks, but on well separated blocks, 2 of which were on deep fertile soil with luxurious ground cover; 2 on ridges where the grass was poor and scanty and the shallow A and B horizons were underlain by stiff sandy clay; and 2 on deep coarse sands of a type found to dry out badly during long periods without rain.

Analysis of this second study may depend upon the homogeneity of variances between treatments, but the simplest approach is to consider the study as involving 2 species x 3 sites x 2 replications within site x 3 treatment classes ("good," "medium," and "poor") x 6 treatments within class, a total of 216 observations of survival percentage.

The third development arose from a previous discussion of the measurements to take of stock from experimental nursery beds, as an index to success of treatment. The discussion was intensified when it was found from an analysis of variance of heights of seedlings that the heights of seedlings which had already been photographed to show conspicuous results from different combinations of density and fertilizer (compost) were not significantly different. A representative row of slash pine seedlings running across a "troughed" bed--one showing conspicuously better growth of the border seedlings--was selected for study. Measurements were made of the seedlings in place, to show not only stem height, but also the average height of the dominant needles; the needles on the borders of the bed (the two outside quarters of the row) were much longer and much more apt to be secondaries. An analysis of stem heights and of needle heights of the outside and inside quarters of the row showed no significant difference in stem heights, despite the conspicuous troughing, but did show a very significant difference in height of needle tips above the surface of the bed. This difficulty in making height measurements of nursery stock is not encountered in longleaf as that species has no stem, and the "height" measured is always the needle-length.

The matter has practical importance in connection with slash pine and other species with ordinary stems, as the grading rules for commercial stock often call for rejection, on the basis of stem length, of excellent seedlings that might be included if a rule based on total stem plus needle length were used.

SILVICULTURE

Allegheny

Stand Improvement

Selection and sample cruises of areas to be used for CCC demonstration plots were made on the sustained yield unit in loblolly pine in Worcester County, Maryland. Samples of past CCC improvement cuttings show that the basal area removed has been approximately the amount which would die naturally during a five-year period. Demonstrations of 10-year and 15-year "mortality cuttings" will be made.

Appalachian

Harvest Cutting in Loblolly Pine. To determine the best methods of harvesting loblolly pine pulpwood in the mid-Atlantic region, plots for 6 methods were established in each of 5 localities. One of the immediate objectives is to determine the relative cost per unit volume of harvesting for each of the cutting methods used. Although complete cost records are not yet available, the following table shows one method of presentation which will be used.

Cost figures for each of 4 cutting methods in one locality were applied to a sample pulpwood stand. The volume of pulpwood to be removed and the man-hour cost of felling and bucking are:

SILVICULTURE (cont'd)

<u>Cutting method</u>	<u>Volume cut per acre</u>	<u>Felling and bucking time^{2/} per unit</u>	<u>Average d.b.h. of trees cut</u>
	<u>Units^{1/}</u>	<u>Man hours</u>	<u>Inches</u>
Thinning	13.27	2.91	7.9
Clear cut leaving 12 seed trees per acre	39.26	1.99	9.4
Clear cut leaving 4 seed trees per acre	42.52	1.92	9.6
Cut all trees 7.0 in- ches and larger	42.17	1.88	10.6

^{1/} Units refer to 160 cubic feet of stacked rough wood.

^{2/} Includes only effective time for felling and bucking.

These preliminary figures indicate that felling and bucking costs per 160-cubic-foot unit will be considerably higher where pulpwood is removed as thinnings than where it is taken as a final crop. In the case cited the man-hour costs are about 50 percent higher for thinnings than for the heavier types of cutting. This difference, which is probably inherent in all thinning operations, is attributed to:

1. The smaller average size of trees removed in thinnings.
2. The lower total volume removed.
3. Actual greater costs of felling when only a small percentage of the standing volume is removed.

Central States

Blackjack oak conversion studies. A preliminary analysis of field data of the conversion studies in Missouri indicated several facts concerning the blackjack oak stands there. It cannot be denied that blackjack oak is a definite problem in the Missouri Ozarks although it is thought that the importance of the problem has been somewhat over-estimated by those having only a "highway" acquaintance with the Ozarks. This point is brought out by the fact that out of 25 stands on the Clark Forest that were thought to be pure blackjack oak from a passing auto, only 15 were actually blackjack stands, while 10 were mixed oak. These mixed oak stands contained more than 60% of the desirable species of oaks and hickory. A similar survey on the Mark Twain Forest showed that 17 out of 25 stands that appeared to be blackjack were actually blackjack and 8

were mixed oak. From these figures (combining both forests) it is found that out of 50 stands that appeared to be blackjack only 32 or 64% were actually so, 36% being of a more desirable composition.

It has been repeatedly noticed that blackjack has a higher mortality rate than the more desirable species of oak and hickory, suggesting that the species is constantly dying out and being replaced by desirable species. 50 stands on each of the Clark and Mark Twain Forests were sampled to check the difference in mortality between species. A preliminary analysis of these data showed the mortality in the past five years to be around 13% for blackjack in the stands sampled as compared to 1½% for post oak and around 2% for all other desirable species. If this great differential in mortality is maintained for several years it may be seen that the number of blackjack stands will be substantially reduced. In this study it was shown that out of 100 stands mapped as blackjack in acquisition five years ago, 14 were actually mixed oak and 86 were blackjack oak, indicating that stand conversion might be partly responsible for the improvement of these 14 stands.

Intermountain

Silvics

Regeneration Factors: Ponderosa pine. A study of the role of plant competition in natural reproduction of ponderosa pine was initiated at the Boise Basin branch station in 1938. The influences upon germination of clearing and trenching small plots, of vegetational type (ceanothus, ninebark, and grass), of exposure (northerly vs. southerly), and of partial shade by the overwood were described in the December 1938 report (p. 46). The relation of these factors to mortality of pine seedlings during their first growing season may be summarized as follows:

The largest and most obvious difference was that between vegetated and bared plots: mortality from all causes averaged 44.7 percent under the heavy competition of brush and grass, compared to 16.1 percent on the companion plots which had been bared and trenched. It is believed that mortality would have been much greater on the vegetated plots in a year when soil moisture conditions were less favorable than in 1938. An attempt to check this seasonal difference by repeat seedings of the same plots in 1939 was essentially a failure because of very poor germination. When mortality from all causes together is considered, there are no significant differences between conditions except vegetated vs. bare.

The most important single cause of mortality was fungi (chiefly damping-off), which killed 12 percent of the seedlings. Insects destroyed 7 percent; heat 4 percent; drought 4 percent; and miscellaneous

and unknown agencies, 3 percent. The order of importance for vegetated plots only is the same as the above general averages. Greatest loss on bared plots was from insects, followed in order by fungi, miscellaneous, heat, and drought.

Mortality due to fungi was 20 percent on vegetated and 5 percent on bared plots. Losses on the three types amounted to: ceanothus - 29, ninebark - 20, and grass - 10 percent. Vegetated plots with shade by overwood lost 27 percent compared to 13 percent for unshaded plots, but the corresponding difference for bared plots was not significant. Mortality was higher in general on north than on south slopes but not consistently so for all types.

Losses of 7 percent on vegetated and 1 percent on bared plots were ascribed to direct heat injury. Mortality percentages for the three types were: grass - 10, ninebark - 9, and ceanothus - 3 percent. On both vegetated and devegetated plots heat kill was about three times greater on southerly than on northerly exposures. The average loss on shaded plots was only 1 percent lower than on unshaded - a difference of no significance.

Mortality caused by drought amounted to 9 percent on vegetated plots, only 0.2 percent on bared plots. Losses on the three types were practically the same. The averages for north and south exposure were also equal. Shaded plots lost relatively more seedlings from drought than unshaded plots in all three types, but the difference was not significant. Evidently the favorable influence of shade in reducing transpiration is more than offset by the added competition from roots of surrounding trees.

The only form of loss which was greater on bared plots than on vegetated plots was that caused by insects, averaging 8 percent and 6 percent respectively. This difference was not statistically significant, however. Differences related to type, shade, and exposure were likewise without real significance although almost so. Losses were heaviest in grass, intermediate in ninebark, and least in ceanothus type. They averaged greater in the open than in the shade and greater on south than on north exposures. The most common and important insects were larvae of the cutworm and white grub type.

Unclassified and unknown losses comprised a very small proportion of the total and showed no relation to the conditions under study. Destruction of seedlings by rodents (0.8 percent) was confined to a few cases of burying or root cutting by moles or accidental entry of mice or chipmunks into the hardware cloth screens that covered the seed spots during the first year.

The experiment shows that competition from other vegetation is a highly important factor affecting first year survival of ponderosa pine seedlings. If competition is eliminated, good survival may be obtained on any site, within the range of conditions covered by the study and in years as favorable from the soil moisture standpoint as 1938. It was also shown, however, that with the practical elimination of rodent damage fairly good first-year survival (average here of 55 percent) may be attained even in a rather heavy cover of grass or brush. The particular combination of type, shade, and exposure conditions that may be most or least favorable probably changes materially according to the predominating cause of death in different seasons. There is a general indication that shade by a living overwood is detrimental or of doubtful value. Although the grass type showed least loss of the three types there is no assurance that it would do so on all sites or in other years. North and south slopes were about equally favorable on the average, but the relation varies so materially with type and for different causes of mortality that the statement of a general conclusion would be unsafe. Data on ultimate survival and on seedling development may show a quite different picture from that described here for the end of the first season only.

Lake States

Growth after Thinning in Young Jack Pine. In the summer of 1929, the Station established a series of plots to study the effect of various degrees of thinning on growth and production of merchantable material in young jack pine. Two periodic remeasurements have been made since then, so that a complete record on the development of these stands during the past decade is now available.

Thinnings were made in a decidedly overstocked stand of 20-year-old jack pine located on medium to good site in the Chippewa National Forest. In all, five plots were employed. One of the plots was left unthinned and the other four were thinned out to 89, 77, 62, and 40 percent of normal basal area. The smaller trees were the ones generally removed. The reduction of the original stocking was more pronounced when considered in terms of number of trees than in basal area.

A summary table below presents a bird's-eye view of the changes that have taken place during the past decade in the cut stands.

Growth in Basal Area and Volume Per Acre

Basal area				Unpeeled volume		Growth for 10 years --		
Per acre		Percent of normal						
After thinning	Ten years hence	After thinning	Ten years hence	After thinning	Ten years hence	On all trees	Per square foot of basal area	On trees expected to survive for next 20 years
<u>Sq. ft.</u>		<u>Percent</u>		<u>Cu. ft.</u>		<u>Cu. ft.</u>		
101.2	139.1	110	113	1,800	3,530	1,730	17.1	-
80.3	128.6	89	106	1,440	3,233	1,793	22.4	578
67.6	121.6	77	103	1,171	2,996	1,825	27.4	635
53.6	114.2	62	98	948	2,604	1,656	30.9	674
36.1	92.7	40	78	649	2,187	1,538	42.6	1,381

One may tentatively conclude, therefore, that the lightly thinned plots will again require thinning in the next decade. Such light thinning may be considered, in other words, as mere conversions from overstocked to normal conditions of growth. The rotation age of these stands is expected to be the same as that of a normal stand growing on the same site. Should there exist a market for all material obtainable from thinning young stands and should the cost of thinning be not prohibitive, then frequent thinnings would become desirable and the light type of thinning would be recommended. If, on the other hand, the wood cut in early thinnings is not marketable, one heavy thinning is advisable. The idea here would be not so much to increase the total production of wood during the life of the stand as to shorten the time required for "crop" trees to attain the desired merchantable size.

Salvage Cuttings in Jack Pine. The Station faces an immediate loss of 20 percent of the jack pine stand on the Cutfoot Sioux Experimental Forest due to an epidemic of spruce budworm and jack pine sawfly, and a possible ultimate loss of the entire stand.

During the past month Zehngraft has completed the marking of 650,000 feet of the dead and dying timber on approximately 200 acres of the forest. To salvage the material it must be removed this winter, which will necessitate a modification of the recommended

procedure for obtaining reproduction. Ordinarily, disk- ing of the ground is done before cutting, but in this case it will be necessary to cut the timber first and bunch the slash in large piles so as to cover as little ground as possible. Then in the spring disk- ing will be undertaken, using K-V money, after which the slash will be scattered over the disked area. Although not as complete a disk- ing job can be done in this manner, it is hoped that the work will nevertheless be beneficial, for otherwise these infested mature jack pine stands will likely revert to brush.

Experimental Forest Furnishes Employment to Local Settlers.

The management plan for the 5,000-acre Upper Peninsula Experimental Forest provides for an annual cut of 500,000 board feet of logs and 2,000 cords of wood, by means of small sales to the settlers living on or adjacent to the Forest.

During 1939, 62 small sales were made and 537,000 board feet of logs, 1,581 cords of wood, and some miscellaneous products were cut. These sales netted the Government \$1,463 for stumpage and re- turned \$15,228 directly to the local community for labor, team hire, operating expenses, and profit.

These small sales furnished part-time employment to nearly 100 local men; several earned from \$300 to \$400 each, but the major- ity received less than \$200. However, these earnings were important, for they supplemented the regular farm income and represented an in- crease in the cash income of the community. The effectiveness of the small sales in stabilizing local farmers is emphasized by the fact that after the sales program was under way there were no local men in the community on relief projects.

Northeastern

Field work in restoration of the hurricane damaged grid and cruise plot systems on the Gale River and Bartlett Experimental Forests was discontinued in early December. The field crews have joined efforts with the computing force in compiling the new cruise inventory for the two forests and summarizing the data from damaged permanent plots scattered through the hurricane zone. The work of reinventorying the forest will be resumed April 1. Progress has also been made in reinstating to a limited extent certain experiments which because of serious hurricane damage had to be abandoned. A large scale sale of hurricane-damaged timber on the Gale River Experimental Forest to a nearby pulp and paper plant is making possible a partial replacement of the 100 acre partial cutting experiment in second growth spruce entirely destroyed by the hurricane. Cutting of these newly established plots will be undertaken next spring. Salvage and cutting operations in a hurricane damaged tract of hardwoods in the Gale River Forest may offer an opportunity for a partial cutting ex- periment in northern hardwoods.

Spruce Management. Preliminary analysis of the 112 plots established in cuttings of various ages in the old field spruce type indicates a fairly satisfactory restocking of spruce and fir. Over 75% of the stands examined support in excess of 2000 conifer seedlings per acre. In general the old field spruce type occupies the better soils of the spruce region. Originally cleared for agriculture, competition in the '70's and '80's from the newly developed farming region in the middle west resulted in abandonment of extensive areas. Continued use of these areas for pasturage purposes by sheep and cattle and consequent grazing back of young hardwood growth made possible the establishment of practically pure conifer stands. However, the original forests which occupied these sites consisted chiefly of beech, birch, and maple with varying admixtures of spruce and fir. That there is a strong tendency for the more fertile and well drained soils to come back to hardwoods was clearly brought out by the study. Whereas prior to cutting, spruce and fir constituted over 90% of the stands on the areas examined, a preponderance of hardwood growth now occurs on nearly 50% of them. It is evident that weeding and release cuttings must form an integral part of any program looking toward spruce and fir production in the old field spruce stands.

Northern Rocky Mountain

Cleanings in Western White Pine. Results on three cleaning plots established in 1935 in the Upper West Branch drainage of Priest River in the Kaniksu National Forest, and remeasured in 1939 give a good example of the possibilities of this type of stand improvement in western white pine. These plots test the freeing of white pine reproduction from competing western larch and lodgepole pine. They were established in dense reproduction, averaging 8 years in age, which had originated following a 1926 burn. Total number of trees per acre at the time of cleaning ranged from 9,000 to 21,000 with an average of 13,000. Average composition of this stand was as follows:

	<u>Percent</u>
Western white pine	5
Western larch	45
Western hemlock	25
Western red cedar	15
Lodgepole pine	1
All other species (5)	<u>9</u>
Total	100

Although the number of pines were adequate for satisfactory stocking, they were so overtopped by other species, especially larch, that they were badly in need of release. A cleaning or weeding was obviously necessary if the future stand was to contain a satisfactory proportion of the valuable white pine.

Treatment on the three plots, each 0.4 acre in size, was as follows:

Plot 165 - moderate cleaning. All white pine and cedar were left, Engelmann spruce and Douglas fir were cut only when crowding white pine, and all larch within 8 feet of white pine were cut. In the absence of white pine, smaller larches were left with an 8-foot spacing.

Plot 166 - Untreated check plot.

Plot 167 - Heavy cleaning. All reproduction except that of white pine and cedar was cut.

The plots were cleaned by CCC enrollees using hand pruners. Trees were cut close to the ground. Only reproduction over 0.5 foot in height was cut in cleaning or considered in stand tallies. Although figures of the labor required for this job were not kept, cleanings similar to these have required from 1 to 5 CCC man-days per acre.

Results of the cleaning in releasing pine are best shown by studying the dominant trees. The tallest tree on each milacre (6.6' x 6.6') unit of area within each plot was considered the dominant tree for that unit, and the sum of these milacre dominants was assumed to make up the dominant stand. How cleaning changes the composition of this dominant stand is shown in the following table.

Effects of Cleaning on
Composition of the Dominant Stand

Species	Composition of Dominant Stand							
	Plot 166 Untreated Check		Plot 165 Moderate Cleaning			Plot 167 Heavy Cleaning		
			1935 Before clean- ing	1939 After clean- ing		1935 Before clean- ing	1935 After clean- ing	
	1935	1939			1939			1939
	<u>Per- cent</u>	<u>Per- cent</u>	<u>Per- cent</u>	<u>Per- cent</u>	<u>Per- cent</u>	<u>Per- cent</u>	<u>Per- cent</u>	<u>Per- cent</u>
Western white pine	1	1	1	45	19	9	70	38
Western larch	90	88	96	35	66	80	0	32
Lodgepole pine	9	10	1	0	1	4	0	1
Western red cedar	0	0	0	10	3	2	30	16
Others	0	1	2	10	11	5	0	13
All Species	100	100	100	100	100	100	100	100
Basis - total number trees	336	336	334	284	322	322	219	309

The moderate cleaning given plot 165 increased white pine in the dominant stand from 1 percent before cleaning to 45 percent after cleaning. The increase on the heavily cleaned plot was greater, from 9 to 70 percent. It is evident that cleaning was very effective in changing the position of white pine from one of subordination to a position of dominance.

During the 4-year period, white pine lost ground to western larch. Small larches left in cleaning and trees of this species less than 0.6 feet in height in 1935 have shown remarkable height growth. This is not as serious, however, as the figures in the foregoing table might indicate. Formerly each pine was dominated by many larches; now overtopped pines are dominated by relatively few larches. A second weeding on plot 165 might profitably be done, but even without such a weeding the white pines on this plot and those on the heavily cleaned plot, 167, have room for development

and have a good chance to form a satisfactory proportion of the future stand.

The greatest effect of the cleanings on development is shown in comparisons of amount and color of foliage and diameter of stems between trees of untreated and cleaned plots. White pines on untreated plot 166 are slender with rather thin, dark green foliage. Those on the two weeded plots are more stocky with dense blue-green foliage. A few measurements of foliage density show that pines on weeded plot 165 had approximately one-half again as much foliage, based on oven-dry weights, as those on untreated plot 166. This relationship of $1\frac{1}{2}$ to 1 held for diameters of stems measured 1 inch above ground line. No difference in height growth during the 4 years showed up between white pines of untreated and treated plots, but a real height difference is almost certain to result in the future.

The results from these plots speak well for this type of stand improvement work in western white pine. Cleanings seem to offer the greatest returns for the expenditure of any intermediate cutting method so far tested.

Direct Seeding with Screens in Western White Pine Type. Second-year results on direct seeding plots sown in the fall of 1937 and the spring of 1938 on broadcast burned areas substantiate the tentative conclusions derived at the end of the first year and demonstrate the possibility of using direct seeding as a method of artificial regeneration in the western white pine type.

Mortality among the one-year-old seedlings caused a decrease in stocking during the second growing season of 4 percent of the total spots sown. New seedlings, however, coming in as a result of delayed germination during the second growing season in spring-sown spots of western white pine and ponderosa pine resulted in a gain of 8 percent over what stocking in all spots would have been without delayed germination, or a net gain of 4 percent over stocking at the end of the first growing season.

Important conclusions derived from these results are as follows:

1. The use of conical screens to keep rodents out of spots of western white pine and ponderosa pine was necessary during the first year after sowing, but the removal of screens at the end of the first growing season did not result in excessive second-year mortality.
2. Fall sowing resulted in 17 percent greater stocking than spring sowing in screened spots of all 3 species tested.
3. Both spring and fall sowing of Engelmann spruce in screened as well as unscreened spots resulted in adequate stocking ranging from 65 to 91 percent of the total spots sown.

Progress at Deception Creek in 1939. Superintendent Bentley's annual report for the Deception Creek Experimental Forest gives a good picture of gross accomplishment on the area in 1939. The forest was opened for business May 2 when the road from Cocur d'Alene was cleared of snow. Favored by an exceptionally long and open fall, it was not left in the hands of the winter caretaker and weather observer until December 24. During this period, 2,623 CCC man-days from Camp F-137, 616 WPA man-days, and 229 man-days from cooperative brush disposal fund were expended.

Some major items of accomplishment are:

Weeding 55 acres to favor western white pine.

Thinning 3 acres in a dense 50-year-old stand of white pine and associates.

Pruning of 2,400 white pine trees to an average height of $17\frac{1}{2}$ feet.

Planting 800 white pine and 1,800 ponderosa pine.

Spot sowing of 20 acres and broadcast sowing of 20 acres to white pine and Douglas fir on a recent broadcast burn.

Construction of $3\frac{1}{2}$ miles of class 2 road for utilization purposes.

Successful controlled burning of 11 acres on a timber sale area.

Burning of slash from 600 M feet of timber cut, and on 10 acres cleared of defective and worthless hemlock.

Timber sales to local loggers totaling 744,210 board feet of white pine and 40,010 feet of larch and Douglas fir. This was taken in the form of a light salvage cutting over about 250 acres.

Roadside cleanup of 2.2 miles of new road.

General maintenance and betterment of forest roads, trails and headquarters improvements.

Pacific Northwest

Douglas Fir Region. During the early part of December the after-cutting examination was made of the partial cutting plots on the Schafer Brothers timber sale, Olympic National Forest, and the data are now being worked up.

Kolbe spent considerable time completing the field work of the Simpson Logging Company installment cutting experiment and immediately began analysis of the silvicultural phases of this work.

The file records of the third series of duff storage tests of northwest conifers (now in the third year) showed normal germination the first year and none the second year except 1.15 percent for western white pine. During the third year there was no further germination of pine but quite unexpectedly the Port Orford cedar produced ten seedlings (0.5 percent) after showing a light germination the first year and none the second.

The fifteen-year progress report of the Douglas fir spacing test plantations indicated a definite, gradual increase for the average tree in height growth, in d.b.h., in crown width, and in limb size, with an increase in width of spacing. The average height of the trees in the 4x4 plantation was 13.9 feet while that of the 12x12 and 17.3 feet. Whether these advantages will hold true for the dominants that will form the ultimate stand remains to be seen. Bole clearing is beginning to take place from natural pruning on the 4x4, 5x5, and 6x6 spacing where the crowns have closed.

In response to a request from the Regional Forester that the Station cooperate in the preparation of marking instructions for the Douglas fir region, Munger spent considerable time preparing a statement of definitions, principles, and procedures to be followed in determining the best method of cutting to employ under various sets of conditions on the west side.

Ponderosa Pine Region. Computations on the Malheur maturity selection cut-over study were completed. From the mortality phase of this study it was found that from the spring of 1938 to the spring of 1939, the first year after cutting, the loss in the ponderosa pine from all causes was 59 board feet per acre, of which 83 percent was attributed to insects.

Rocky Mountain

Logging lodgepole pine on experimental forest. Lodgepole pine methods-of-cutting plots which were established in 1937 on the Fraser Experimental Forest are being logged with ERA help this winter. Progress made thus far indicates that logging will be completed before the coming growing season and will remove more than one million board feet from twenty five-acre plots. The methods of cutting represent a range of treatment from commercial clear-cutting to natural selection.

Prior to snowfall an extensive system of logging roads was completed which makes all plots accessible. Logs will be skidded

and sold in decks at convenient points. A portion of the timber is, however, being saved for future construction work at the experimental forest headquarters. This material is carefully selected and marked before cutting for house, power, and telephone poles.

In spite of several weeks of subzero weather, felling and skidding has progressed at a satisfactory rate. Logs are being skidded to a central lane within each plot by horses and from there to decks along the logging roads with a caterpillar tractor. Observational evidence indicates that very little damage to reproduction has resulted from this procedure.

The study is unique in that it represents the cooperative efforts of both the division of forest influences and forest management; and is the first large scale attempt to study lodgepole pine in the region on the basis of replicated plots representing a wide range of methods-of-cutting. Eventually, it is hoped that the plots will yield valuable information on the effect of cutting methods on snow storage as well as growth, mortality, and natural regeneration.

Southern

Silvics

Development of a special tool for injecting poison into trees.

Field tests by various experiment stations have shown that poisons such as arsenites and chlorates are very effective in killing undesirable hardwoods. Poisons are most effective when they come in contact with the cambium tissue. It is therefore unnecessary to inject poison deeply into a tree. Numerous shallow injections are more effective than a few deep ones. To accomplish this purpose an inexpensive tool has been developed recently at the Harrison Experimental Forest.

The tool consists of an ax with a special attachment, made from $\frac{3}{4}$ inch octagon tool steel. It measures $3\frac{1}{8}$ inches in length, of which $1\frac{1}{2}$ inches is tapered to $\frac{9}{16}$ inch at the end. A $\frac{1}{2}$ -inch hole is then bored for a distance of $1\frac{1}{8}$ inch from the tapered end. From this point an oval opening, $1\frac{3}{4}$ inches by $\frac{1}{2}$ inch is made to a depth of $\frac{1}{2}$ inch. The tapered end has a slope of $\frac{1}{8}$ inch. The attachment is welded to the flat end of a single-bitted ax head. One stroke into a tree with this tool removes a core over an inch long and $\frac{1}{2}$ inch in diameter and leaves a clean hole for poison application. It is possible, therefore, to make many injections of poison into a tree without much effort and in a very short time.

SouthwesternHarvest Cuttings.

The Bimonthly Report of October 1, 1939, (pp.59-61) carries an account of a second cut of ponderosa pine then in progress. The logging and slash disposal were completed in December. Since the area is a sample plot on which records have been carried since the first cutting 30 years ago, pertinent data acquired since the October report are here presented.

The original stand, as computed from timber sale records, was 9,633 board feet per acre, of which 63.5 percent was cut in 1909, leaving 3,520 board feet.

Net increment from 1909 to 1939 totaled 2,418 board feet per acre of 80.6 feet annually. This increment brought the average volume per acre to 5,938 board feet in 1939.

The 1939 cut removed an average volume of 2,461 board feet per acre, net scale. Under the three methods of cutting: (1) Selection Favoring Dominants, (2) Selection Favoring Subordinates, and (3) Salvage Cutting, the percentage of volume removed was 54.6, 59.6, and 35.3 respectively.

Localized heavy cutting, on account of mistletoe and other defect, tends to obscure volume differences between (1) and (2). Under both methods are found many areas several acres in extent which are almost devoid of trees above the sapling stage. Comparison of the two methods must resort to selection of plots or groups each of which conforms to the method it represents.

Logging, together with old sheep bed grounds, has left about 20 percent of the area in need of restocking. Although adequate seed trees have been left, the outlook for prompt reproduction on these spots is not reassuring, in view of the fact that very few seedlings have started at any time since 1919.

Because the dense reproduction in most places rendered slash burning impractical, the slash was handled by a modified form of lopping and scattering which aimed especially at release of young pines.

Fire protection relies in large part on fire lines made by removing slash 20 feet on both sides of all utilization roads. These cleared strips are not expected to stop fires but to serve as lines of attack by fire fighters.

A deposit of \$1 per M under the Knutson-Vandenburg Act makes available a fund of \$2.46 per acre for "stand betterment." A portion

of this fund has been used for "seedling release" supplementing the slash disposal performed by the contractor; and an additional portion has been or will be used for eradication of mistletoe and pruning. Pruning is confined to trees below 18 inches d.b.h. which have already cleared their boles to such extent that only light work is necessary. It is expected that these operations will leave a residue of about \$1 per acre to be used some 5 years hence in pruning dominants or poisoning wolf trees of the present sapling class.

Growth records of the past 30 years show that the periodic net annual increment reached a peak of 115 board feet per acre in the second 5-year period, then declined steadily to 50.2 in the last period. At the end of 20 years the periodic annual increment had fallen to 76 board feet but the mean for the 20 years was 91 as compared with 80.6 for the 30 years.

Silvics

Periodic measurements on the current leader growth of several junipers were taken during the past field season from May through October. The trees were young and open grown and were located near Walnut Canyon, about 10 miles southeast of Flagstaff.

A string was tied around the leader about 2 inches from the tip to serve as a reference point and measurements were taken with a steel rule graduated in millimeters. The leader growth by 10-day periods for eight sample trees is given in the following table. Trees numbers 1, 2, 3, and 4 are Utah junipers and the other four are one-seed junipers.

10-day period ending	Height growth in millimeters								Average
	#1	#2	#3	#4	#5	#6	#7	#8	
5/20	5	5	1	1	2	2	1	3	2.5
5/30	2	5	2	1	2	2	2	5	2.6
6/9	2	4	4	2	2	1	3	4	2.8
6/19	2	4	4	2	3	1	3	4	2.9
6/29	2	5	4	2	3	2	2	4	3.0
7/9	1	0	1	1	1	0	0	3	.9
7/19	0	0	0	1	1	0	0	0	.2
7/29	0	0	0	0	0	0	0	0	.0
8/8	1	1	0	0	0	1	2	1	.8
8/18	4	2	1	1	2	1	1	2	1.8
8/28	3	2	2	1	1	1	1	1	1.5
9/7	1	1	1	1	1	2	2	0	1.1
9/17	1	1	1	1	1	1	1	1	1.0
9/27	1	1	0	1	1	1	1	0	.8
10/7	0	0	0	0	0	0	0	0	.0
10/17	0	0	0	0	0	0	0	0	.0
Total	25	31	21	15	20	15	19	28	21.9

Seasonal growth had already begun when the first measurements were taken on May 10, and continued through May and June. Leader growth tapered off abruptly about July 1 and remained at a standstill through most of July. A secondary period of height growth began the second week in August and continued through September, terminating about the first of October. The average height growth during the first growth period (15 mm.) was a little over twice that of the second period (7 mm.).

The two distinct growth periods are attributed to the acute drought experienced in northern Arizona during the spring and summer of 1939. The total precipitation at the adjacent Walnut Canyon pinon plot for the period May 10 to July 24 was only .25 inches. The heavy summer rains which usually start about the first of July were deferred until the last week in July. Precipitation during August and September was plentiful, with almost 2 inches during the first 10 days of August. The reserve moisture, stored in the soil from winter rains, was evidently sufficient to carry the primary growth through May and June. When the soil became exceedingly dry in July, growth practically stopped, but resumed following the first heavy rains in August.

The aptitude with which native junipers cease active growth when soil moisture is deficient, and resume growth when soil moisture conditions are again favorable may account for their ability to survive on dry exposed sites and may also account for the formation of false rings which are characteristic of the wood of southwestern junipers.

FOREST PRODUCTS

FOREST PRODUCTS STATISTICS

Northern Rocky Mountain

Census

Mailing of the first request to 870 lumber and timber products manufacturers in this region was started on January 15. A good response is being made by the operators, and to date 197 returns, now in various stages of editing, have been received. In addition, a consignment of completed schedules received on January 27 from the regional forester at Ogden included reports from about 18 percent of all South Idaho concerns to be canvassed by Region Four.

Wholesale Lumber Selling Prices. Arrangements were made with the Western Pine Association to furnish on a quarterly basis, as well as the usual monthly basis, the data necessary for the "quarterly" reports. Preparation of the "quarterly" reports from the monthly material required considerable work at the station which will hereafter be eliminated.

Christmas Tree Production. Christmas tree production in western Montana reached an all-time peak in 1939 with an estimated production of 1,967,350 trees compared with 1,676,000 in 1938, the previous banner year. Montana is attracting considerable attention as a source of Christmas trees, as is indicated by the number of inquiries which the station receives.

Pacific Northwest

Log and Lumber Census. During the month 2,536 schedules were sent out to the operators in Oregon and Washington. Of the returns, 110 approved schedules were sent to the Washington office.

TIMBER HARVESTING AND CONVERSION

California

Ponderosa Pine, Log Grades. Following the Inter-station log grading conference held at the Feather River Branch Station in November, the division met with the products divisions of the Northern Rocky Mountain and Pacific Northwest Stations at Portland in December to prepare detailed recommended grading rules for ponderosa pine logs for use over its entire range. Subsequently the recommended rules were distributed to western Forest Service offices and experiment stations and the western pine industry for review and comment.

Redwood Mill Study. In response to a request from the Rockport Redwood Company, Rockport, California, conferences were held with officials of the company, the California Redwood Association, the Division of State and Private Forestry, the Region 5 office and the station Division of Redwood Management, relative to a short mill study designed to furnish information on a minimum diameter limits needed by the company before opening up a new area on a selective cutting basis. Subsequently material for the study was marked in the field, and mill

layout analyzed preparatory to conducting the mill study in cooperation with the Regional Office and Division of Redwood Management and the Redwood Association. The study will furnish data useful in formulating redwood log grades, the need for which is further emphasized by a request for such grades just received, for use in evaluating value of logs in a sale being made on a log basis. L. N. Ericksen, Senior Wood Technologist.

Northeastern

Production Cost Studies. Production cost studies of pulpwood operations in second-growth spruce and fir stands provide a basis for determining under what conditions it is more economical to handle an area as a skidding or a yarding chance. In developing equations to indicate skidding and yarding time, observations were restricted to comparable jobs where travel conditions were classified as good; ground neither soft nor wet enough to materially affect travel time, topography either level or sloping moderately from woods to landing.

The following regression equation for skidding with one horse has a standard error of ± 3.77 minutes:

$$T = \frac{.029 D + 6.8 L + .89 N - .65}{L}$$

in which T = skidding time per cord in minutes
 D = distance in feet
 L = load in cords
 N = Number of trees in load

A team and driver are the working unit in the following yarding formula:

$$T = \frac{L (1+U) + .019 (D)}{L}$$

in which T = yarding time per cord in minutes
 L = load in cords
 D = distance in feet
 l = loading time per cord in minutes
 U = unloading time per cord in minutes

To illustrate the utility of the equations, assume a stand in which trees have an average diameter of 8", a volume of .0678 cords; these to cut out 7.5 four-foot sticks per tree; 110 of which equal a cord of pulpwood.

TIMBER HARVESTING AND CONVERSION (cont'd)

Assuming a 350' hauling distance with skidding and yarding loads of .19 and 1.3 cords respectively, solutions for the equations follow:

$$\text{Skidding time per cord (minute)} = \frac{.029 (350) + 6.8 (.19) + .89 (2.8) - .65}{0.19} = 70^{\circ}$$

$$\text{Yarding time per cord} = \frac{1.3 (32+15.5) + .019 (350)}{1.3} = 52.60$$

With these results and presuming a man with one horse received 60 cents per hour for skidding, and a team with driver 80 cents for yarding, costs are identical: 70 cents per cord. Travel distance is the important factor in skidding, 100 feet making a difference in costs of 15 cents per cord while loading and unloading time are major considerations in yarding; 100 feet difference in distance would alter yarding costs per cord only 2 cents. Although skidding appears cheaper up to 350 feet and yarding more economical for greater distances, this direct comparison between yarding and skidding costs does not properly indicate skidding limitations when all factors are considered.

This study showed that bucking and piling can be carried on more efficiently at the landing than in the woods. It costs \$1 per cord to buck and pile 8" trees in the woods before yarding, as compared with 67¢ for skidded trees worked up at the landing. Consequently, even though skidding or yarding costs 70¢ per cord for 350', the 33¢ differential as a result of added efficiency in handling the trees at the landing substantially increases the economical skidding distance. The marginal distance may readily be determined by solving the following equations simultaneously.

Skidding:

$$0.70 + 0.33 = \left[\frac{0.029 (\text{Dist.}) + 6.8 (0.19) + 0.89 (2.8) - 0.65}{0.19} \right] = 0.01$$

Yarding:

$$0.70 = \left[\frac{1.3 (47.5) - 0.019 (\text{Dist.})}{1.3} \right] 0.013333$$

The result is 600 feet; skidding and yarding costs for which would be \$1.08 and 75¢ per cord respectively.

Northern Rocky Mountain

Ponderosa Pine Log Grades. During the latter part of December, Rapraeger represented the station at a meeting at Portland, Oregon, held for the purpose of standardizing log grades for ponderosa pine. Other attendants represented the California and Pacific Northwest Stations and the lumber industry. At the meeting standard grade descriptions were prepared, mimeographed and distributed to interested agencies for their comments.

Pacific Northwest

General. The committee, consisting of Rapraeger of the Northern Rocky Mountain Station, Orr of the California Station, and Lodewick of this Station, appointed at the Inter-Experiment Station Log Grading Conference in November, met in Portland in mid-December. During the meeting a new set of log grades for ponderosa pine was developed and received committee approval. The grades proposed are based upon external characteristics so that they may be used for standing trees as well as for logs, are believed to be applicable throughout the range of the species, and should provide fairly well-defined and evenly spaced value segregations for any group of logs. Four grades, three of which are again divided into two subgrades each, are provided for in the proposed system. Use of the 4-grade system is suggested for general appraisals and for the sale and purchase of logs; the 7-grade system should be used in all research work and in appraisals where differentials between timber values are desired. It is expected that the newly proposed grades will eventually be adopted as official by the Forest Service and by the pine industry.

Pine Mill Studies. The second of the proposed check studies at the J. Neils Lumber Company's mill at Klickitat, Washington, was started on January 15 and the field work is about half done. During a two-week period 907 pine logs were followed through the mill. All of these were graded under the 6-grade Pacific Northwest rules and under the newly proposed grading rules, thus providing a means of correlating the two systems. In addition, some 800 additional time study logs were graded under both systems. Field work on this study should be completed about February 20.

Selective Timber Management in Douglas Fir. Computational work on the so-called Crown-Zellerbach tax depletion study has been completed. This is a project which is being conducted under the immediate direction of Carlson of the Division of State and Private Forestry with Brandstrom acting as consultant and contributing WPA computing help. The study consists of an economic stand structure analysis using the technique and general approach developed during the last few years in our ponderosa pine case studies.

It was found that the log diameters recorded for the logs in the raft averaged 2 inches less than the corresponding diameters measured in the woods after the trees had been felled and bucked. One inch of this 2-inch difference is accounted for by the fact that the logs in the water are scaled the narrow way in contrast to the woods measurements which approximately give the average diameter. Another half inch difference comes from recording the woods measurements to the nearest inch in contrast to the commercial scaling practice of always recording the lower inch (i.e., dropping the fractions). Finally, the commercial scalers lost about one-half inch by over-allowing for bark thickness on the submerged side of the log which they cannot see.

As a result of this 2-inch shrinkage in the recorded diameter of the logs the board-foot volumes for the generally large logs involved in this study are reduced on the average by 8 percent. A further reduction of approximately 15 percent is shown for defect allowances. Preceding these volume losses for the logs in the raft is a loss of approximately 13 percent, representing logs called or broken in the woods, which brings the total difference between the gross woods scale and the net water scale to 36 percent.

FOREST AND RANGE INFLUENCES

EFFECT OF COVER ON CLIMATE

Lake States

Effect of Shelterbelts on Snow Accumulation. A survey of the shelterbelts in the Great Plains Region revealed that, on the lines of apparently equal effective rainfall, tree plantings in the north had an average life span of approximately 20 years more than in the central or southern portion of the region.

Although this may partially be explained on the basis of a longer growing season in the south and consequently a more rapid exhaustion of the subsoil moisture, a further explanation may be found in the effectiveness of the shelterbelts in accumulating snow in the northern part of the region.

Shelterbelts with one or more rows of dense-growing shrubs at least 8 feet high are very effective in trapping snow in drifts ranging from 5 to 8 or more feet in depth. The snow is practically all stopped in a zone from 30 to 80 feet wide, on the lee side of the first shrub row.

Open-grown narrow belts of tall-growing species devoid of limbs near the ground line allowed the snow to sweep under the belt and be deposited in a thin sheet averaging 1 to 2 feet in depth on the lee side, in a zone extending from one-half to ten times the height of the belt.

Where shelterbelts were of such design as to cause deep snowdrifts in the belt, the increase of soil moisture from fall to spring was equivalent to 10 inches of water, while the crop areas within 80 feet of the belt showed an increase of 5 inches of water, due largely to the lateral movement of moisture from melting snowdrifts.

FLOOD CONTROL SURVEYS

Allegheny

General. The Infiltration School, planned by the Working Committee, was held at Kittanning, Pennsylvania. Representatives of the Forest Service and Soil Conservation Service from Washington, the Allegheny, Northeastern, Central States, and Appalachian Stations attended this conference. At this meeting the need for improvement of infiltration equipment was discussed. The meeting was very helpful in bringing various schools of thought to bear on the plans and techniques proposed for the conduct of infiltration studies.

E. J. Rogers attended the Photogrammetry Seminar held in Washington. At this meeting an informal discussion took place dealing with the use of aerial photographs on flood control surveys.

Preliminary Examinations

The Poquest report is ready for submission to the Field Coordinating Committee. An examination of the Turtle Creek Watershed in southwestern Pennsylvania is nearing completion.

Appalachian

Preliminary Examinations

Preliminary examination work was resumed in December after several months delay occasioned by the urgent demand for survey work outlines and the initiation of new surveys. Preliminary Examination reports for the Big Sandy and Little Kanawha watersheds are being prepared and should be complete within the next two months.

FLOOD CONTROL SURVEYS (cont'd)

Watershed Surveys

Survey activities have been somewhat handicapped by the severe winter weather prevailing during December and January. Substantial progress has been made on the Potomac River Survey despite these conditions and work in general is running according to schedule.

Flood damage investigations, hydrologic studies and the classification of the watershed have made significant progress and it is planned to push these phases of work as rapidly as possible, since they are very important to subsequent studies in designing a flood control remedial plan for the watershed.

Progress is being made on the Pee Dee River Survey, in which the Station is cooperating.

Central States

Preliminary Examinations

The preliminary examination report for the Wolf River Basin in Tennessee and Mississippi was submitted the last of January. The Hatchie River has been given preference over the Cumberland River as the next watershed for study in the Committee 11-A area.

The Forest Service representative in Committee 14-B has been working on the preliminary examination reports for the Chariton River in Missouri and the Iowa River in Iowa.

The Wabash River preliminary examination report is partially written and some sections have been submitted for review. The Scioto River Basin has been selected as the next one for preliminary examination in the Committee 4 area.

Watershed Surveys

St. Francis Survey report has been completed.

The Muskingum Survey is progressing as rapidly as possible. The Unit Report on Raccoon Creek is nearing completion and is expected to be ready for review by February 15.

Pacific Northwest

Progress. The work outlines for the Walla Walls and Willamette watersheds were completed. The final draft on the preliminary flood control report for the Puyallup River is ready for signature by members of the field committee.

FLOOD CONTROL SURVEYS (cont'd)

Organization. The BAE has detailed two men, Mr. Newman and Mr. Eliason, to the Northwest to assist in flood control work. These men reported for duty January 1 and make their headquarters at the Station. This should do much to speed up the work which has been handicapped by the great distances separating different members of the committee.

Travel. Bolles and the BAE men took a 3-day field trip over the Puyallup watershed during January. A dam designed solely for flood control purposes is being constructed by the Army Engineers at Mud Mountain on White River, the largest tributary of the Puyallup. This dam is to be completed by November 1942 and the Army Engineers predict that it will provide protection to the City of Tacoma from a flood 50 percent greater than that of 1933. Recently the Federal Power Commission requested the War Department to explore the possibilities of so constructing this dam that it could later be raised and used for power development and the Department of Agriculture has been requested to find out what could be done in the way of an upstream program to protect this structure from excessive sedimentation.

Rocky Mountain

Work plan for intensive study prepared. A work plan for a hydrologic study in the Bear Creek watershed west of Denver, Colorado, has been prepared and submitted for review. The study is designed to provide information on watershed problems in the foothills of the eastern slope of the Rocky Mountains. Particular emphasis will be placed on flood and erosion control problems and an effort will be made to determine the influence that topography, soil, vegetation, land use, drainage pattern and storm characteristics have upon runoff and erosion. It is proposed to study eleven selected drainage units intensively. The drainages are from 51 to 5,478 acres in size and each will be equipped with a stream-gaging station, including provision for silt sampling, and rain gages. Precipitation on the entire study area will be measured by 53 rain gages, including 10 reconnaissance recording gages, 32 electric tipping bucket gages with two central records, and 11 standard rain gages. Class "A" weather stations will be placed on opposite sides of the study area at an elevation of about 7,000 feet.

The study will begin by determining the physical and hydrologic characteristics of the drainage units after which the land will be treated and the effects of treatment determined. The study will involve the installation and operation of weather stations, rain gages, stream and silt gaging stations; measurement of climate, precipitation, streamflow and silt movement, and environmental factors such as slope, soil, vegetation, land use, and infiltration; and the compilation,

analysis, interpretation and publication of data. Cooperation in conducting the study is being sought from the U. S. Geological Survey, Colorado State Engineer, and city of Denver.

Infiltration. In connection with the study of infiltration indices for the Cherry Creek Flood Control Surveys, analysis has been completed to show the influence of forest factors on infiltration capacity of podsolized forest soil. Infiltration capacities for this soil were determined by the North Fork infiltrometer on 36 plots in the ponderosa pine type. On half of these plots the litter and duff layers were removed in order to determine their effect on infiltration capacities. Detailed soil descriptions were obtained for each plot in an effort to determine the factor or group of factors most influential in determining rates of infiltration.

The podsolized forest soils are derived solely from conglomerates. Their thickness varies from 12 to 40 inches, averaging about 30 inches. The topsoil generally consists of a one-inch humus layer, a transitional horizon of fine sandy loam about two inches thick, and an ashy gray, acidic, leached layer of light loamy sand 15 to 20 inches thick. The subsoil is light gray, loamy sand interspersed with lenses of brown sandy clay.

The average infiltration capacity under natural conditions was 1.52 ± 0.16 inches per hour. Removal of the litter and duff layers reduced this rate to 0.92 ± 0.10 inches per hour. On a statistical basis this difference (40 percent) was highly significant.

To determine the most important factors influencing infiltration rates a correlation analysis was made involving infiltration capacity, depth of duff layer, depth of humus, thickness of transition layer, and thickness of A₂ horizon. Of these factors only the thickness of the transition layer showed a close relationship. The correlation coefficient between this factor and infiltration capacity ($r = .593$) was highly significant for the plots from which the litter and duff layers had been removed and almost highly significant on the natural plots ($r = .567$; "r" at the 0.01 level = 0.590).

Southern

Preliminary Examinations

During the past two months the office has participated in preparation of plans for an examination of the Upper Red River in Texas and Oklahoma, under the chairmanship of the Soil Conservation Service. Other plans for a preliminary examination of the Tombigbee River watershed, under Forest Service chairmanship, are being made. The contemplated examination will be more comprehensive than any

engaged in by this office. Field work will receive more emphasis than formerly, including a brief but intensive reconnaissance damage appraisal, more accurate determination of flood-problem areas, and more accurate determination of priority of study of problem areas. This it is hoped will obviate necessity of similar work in subsequent surveys and reduce the liability of erroneous recommendations regarding surveys. The methods to be used will resemble those employed in the preliminary phase of the Yazoo summary hereafter mentioned.

Detailed Surveys

This office is assisting in the final steps of preparation of the South Concho River survey report under Soil Conservation Service chairmanship.

Approximately 4 months' work has been done on the Neosho-Grand survey, for which the Forest Service is furnishing 3 men. The South Concho survey will be followed by a survey of the Middle Colorado River, in which this office will be represented by several technicians. The Station is also participating in the Lower Arkansas survey; field work was initiated on February 1. All three surveys are under Soil Conservation Service chairmanship.

The third revision of the White River survey outline is essentially complete. All revisions were necessitated by changes in survey area authorization. Initiation of field work is pending approval of the outline; practically all of the Forest Service technicians are ready for transfer to the Harrison, Ark., headquarters for this survey, which will be under the chairmanship of the Forest Service.

Field work on the Yazoo survey under Forest Service chairmanship has been in progress for several months. A unique preliminary study or survey planning reconnaissance was employed and a recent report indicates that it was a worth-while and unusually thorough investigation. In effect, this study admirably fulfilled the requirements of a preliminary examination, requirements which are often not fulfilled by the conventional type of preliminary examination based on little or no field work. The basic character of the study is a carefully planned, purposeful reconnaissance of the watershed, conducted by a relatively small group of technicians. The technicians were selected on the basis of experience, and knowledge of the watershed, knowledge of flood-survey requirements, and pertinency of each technician's field to the significant problems to be solved. Only those features of the watershed known to contribute to flood problems were investigated. The main feature of the reconnaissance was the considerable amount of quantitative data that was obtained. Data were recorded on more or less standardized tally sheets and properly keyed into base maps. Field work on this activity lasted approximately 1

month and furnished quite detailed information as contrasted with the usual broad estimates and impressions customarily obtained on short-term field studies of this type. In the absence of similarly comprehensive work in preliminary examination, as is usually the case, a reconnaissance such as that made on the Yazoo project will prove invaluable in delineating flood-problem areas, establishing study priorities, and providing a basis for planning and scheduling a detailed survey.

INFLUENCE OF NATURAL VEGETATION ON STREAMFLOW

Appalachian

Freezing of ponding basins. The unusual cold during January presented difficulties in taking field records, never before experienced during the course of Forest Influence studies at the Station. For the most part ponding basins became frozen over, but the water within six inches of the blade remained open, which permitted obtaining a head record by means of hook gauge readings, even when the stilling wells were frozen. The ground froze to approximately twenty inches. However, the 12-inch snow fall that accompanied the cold weather produced practically no rise in the streams during the period of melting. There is evidence that much of the snow disappeared by evaporation.

California

Watercycle & Soil Studies

North Fork. The precipitation at North Fork for the 1938-39 season was 24.84 inches, approximately 25 percent below normal. The surface runoff from the plots burned annually until the 1938-39 season and now supporting a 2-year growth of volunteer vegetation was equal to approximately 6.8 percent of the total precipitation. The surface runoff from the twice burned plot with a 3-year growth of volunteer vegetation was less than one percent of the precipitation and from the plots with an undisturbed vegetation only a very small trace. The erosion rates from the annually burned, twice burned, and undisturbed vegetation plots were 3180 pounds, 7.5 pounds, and none, respectively. The results thus show a very rapid decrease in erosion and a definite but somewhat less rapid decrease in surface runoff with the reestablishment of the natural vegetation.

The results of the small lysimeter studies for the 1938-39 season to determine the influence of ponderosa pine litter on the soil water relations are shown in the following table. It is interesting to note that the surface runoff was slightly greater from the tank on which the litter had only recently been removed than from the tank maintained with a bare soil since establishment.

Table 1. Surface runoff, percolation, and evaporation from the North Fork rectangular lysimeters, 1938-39 rainy season. (Each tank 1000 sq. in. in area, 21 in. deep.)

Tank number ^{1/}	Rain	Surface runoff	Perco-lation	Evapo-ration
	<u>Inches</u>	<u>% of ppt.</u>	<u>% of ppt.</u>	<u>% of ppt.</u>
12	24.77	4.85	60.36	34.80
15	24.77	9.61	54.50	35.89
13	24.77	21.96	31.21	46.83
14	24.77	28.30	25.68	46.02

^{1/} Established in 1932; tank 12 maintained with 2-inch ponderosa pine litter cover since establishment; tank 15 bare soil covered with 2-inch depth of ponderosa pine litter for first time in 1937; tank 13 maintained with bare soil since establishment; and tank 14 litter burned off for first time in 1937 and since maintained with bare soil.

The lysimeter studies on the consumption of water by one of the local grasses, Bromus mollis, during the past season show that there were from four to five inches more evaporation loss from the two tanks containing grass than from the two bare soil tanks. These results cannot, however, be considered as applicable to natural conditions, as the lysimeters do not provide for unrestricted surface runoff, thus permitting a greater amount of percolation, particularly from the bare soil tanks than would have occurred under natural conditions.

The results of the study on the loss of rainfall by interception for the season show that on the undisturbed surface runoff and erosion plots slightly over 20 percent of the seasonal precipitation

INFLUENCE OF NATURAL VEGETATION ON STREAMFLOW (cont'd)

was intercepted by the vegetation. More than 75 percent of this amount, however, eventually reached the ground as stemflow, and only about 25 percent, or approximately 5 percent of the total precipitation, was lost due to surface evaporation from the vegetation.

Base Lake. The results of the surface runoff and erosion plot studies at Vass Lake for the past season showed a very slight but insignificant increase in runoff and erosion as a result of the burning of the ground cover on one of the triplicate sets of 1/40-acre plots. This may in part have been the result of the lack of high intensity rainfall and of a total precipitation approximately 48 percent below the average of the preceding four years and in part to the fact that rains did not occur until a new fall of needles, affording a fairly good ground cover, had occurred. The results so far this season indicate that there will be, with normal rainfall, an appreciable increase in both surface runoff and erosion as a result of the second burning of the ground cover.

Berkeley. Only about 13 inches of rainfall were recorded at the Oxford Street lysimeter installations during the 1938-39 season. As shown in table 2, even this small amount of precipitation resulted in tremendous difference in the surface runoff, percolation, and evaporation from the tanks as influenced by the differences in the depths of the Monterey pine litter cover. As would be expected, the greater differences occur between the bare soil tanks and the tank with a 1/8-inch depth of litter cover. For the tanks with a litter cover of 1/2-inch depth, or greater, there were only small differences in runoff, percolation, and evaporation.

Table 2. Surface runoff, percolation, evaporation, and erosion from tanks for different depths of Monterey pine litter cover.

Litter cover	Rainfall ^{1/}	Surface runoff	Percolation	Evaporation	Erosion
Inches depth	Inches	% of ppt.	% of ppt.	% of ppt.	Grams
1.5	12.29	5.21	47.36	47.44	1192
1.0	12.93	2.09	46.48	51.43	Trace
1/2	13.15	6.54	41.52	51.94	None
1/8	13.26	11.92	31.90	56.18	None
0	13.41	23.71	13.87	62.42	None

^{1/} The differences in precipitation are largely due to bad wind disturbances.

In Strawberry Canyon the results of the thinning experiment on the Ceanothus cuneatus series of chaparral lysimeters for last year showed that complete denudation or removal of the vegetation resulted in 0.2 inch increase in surface runoff and 5.7 inches increase in percolation, with a corresponding decrease in evaporation. A 78-percent reduction in the density of the vegetation resulted in a 1.4-inch increase in percolation and a corresponding decrease in evaporation; whereas a 32-percent and a 15-percent reduction in the vegetation cover did not significantly change the runoff, percolation, and evaporation relationships as compared to those of the unthinned tank.

Infiltration Studies. A publication, "The construction, operation, and use of the North Fork Infiltrimeter," has been submitted for printing and should be ready for distribution during February. The publication includes complete descriptions and specifications for the equipment, a discussion of sampling procedures, and detailed instructions for the installing and operating of the instrument and for the collecting and recording of field records. A discussion and examples of a new method for the analysis and interpretation of infiltration data is also included.

An infiltration study employing the North Fork Infiltrimeter, made in cooperation with the Bureau of Reclamation on a 100-acre watershed near Friant, California, has been completed. Although the data collected during the study has not been completely analyzed, it has served to demonstrate the usefulness of the infiltrimeter in distinguishing differences in the surface runoff and erosion characteristics of different areas and to determine the influence on infiltration of such factors as differences in soil, vegetation, topography, and land use, P. B. Rowe, Associate Silviculturist.

San Dimas Experimental Forest

Precipitation and Streamflow. The first significant storm period since last September occurred during the first part of January, bringing from 5.80 to 9.50 inches of rain to the Experimental Forest. The heaviest phase of this storm period occurred on January 7 and 8. It totalled about four inches and was characterized by a series of heavy intensities, the maximum being 3.24 inches per hour for a 5-minute period. A sustained intensity of 0.72 inches for 1 hour was recorded at the same location, just east of Tanbark Flat. Complete records were obtained at all stream gaging stations and intensity rain gages.

Flashy, debris laden flows were produced from the year-old burn in the upper San Dimas drainage, including the Fern watersheds. These flows continued on down Fern Canyon, overtopping the 3- and 4-foot San Dimas flumes at gaging stations Nos. II and IV respectively. All the reservoirs at the Fern watersheds were filled with

INFLUENCE OF NATURAL VEGETATION ON STREAMFLOW (cont'd)

debris to about two-thirds of their capacity. Maximum flows at all the other streamgaging stations were carried easily by the 3-foot San Dimas flumes, while at the Bell multiple watersheds the flows were clear and did not exceed the capacity of the 90° weirs.

Runoff and Erosion Plots. Excellent records were obtained at the Fern plots where surface runoff for the period January 7-8 ranged from 0.6 to 4.05 percent of the rainfall. During the peak of the storm runoff was measured well in excess of 30 percent. The Tanbark and San Dimas plots produced negligible amounts of runoff.

Instrumentation. The rehabilitation of the rain gage system in the Fern multiple watersheds has been completed. The towers which formerly supported the gages at the top of the vegetative canopy have been removed. The gages are now mounted on platforms built out on the downhill side of the trails and designed to keep the gages from being buried or drifted over by snow.

A notable improvement has been made to the Fergusson type intensity rain gages by Lowell Andrews, Minor Assistant to Technician. It consists of a supplementary weight added to the pen arm counter-balance. Considerable trouble had always been experienced with these weighing type gages due to the pen dragging on or digging into the chart. Not a single failure of record with this type of instrument has been noted this season since the change has been made.

The Fern runoff plots have been completely equipped with new type recording mechanisms employing Mercoid switches. New lead covered cable has also been installed, replacing the temporary wiring put in after the fire. The runoff tipping buckets were rebalanced and calibrated and all eroded material for the season thus far has been collected from the baffle troughs and silt traps.

Vegetation Survey. The initial unseasonal growth due to the September rain and subsequent warm weather of October and November has been followed by a period with no growth in both herbaceous and woody plants, due to the cooler dry weather. However, there has been little drying or frosting of the new growth.

There was abundant germination of mustard in the Fern Canyon burn following the September rain. On the south facing slopes, the dry weather during the fall killed over half of the seedlings and stopped the growth of the rest; but on the north facing slopes, there is now an excellent cover of mustard from six to twelve inches high which offers good protection in these areas. The rapid development of lupine and purple yerba santa during the summer of 1939 and the sprouts from the root crowns of oak, manzanita, Ceanothus, etc. have produced a good protective cover on the gentler slopes of Fern Canyon.

-- J. D. Sinclair, Silviculturist.

Intermountain

Infiltration studies of an informal and exploratory nature were conducted in the early fall of 1939 on soil characteristics of the Ephraim Canyon (Manti Forest) watershed at 10,000 feet elevation, and Parrish Creek (Wasatch Forest) watershed at 8,300 feet. Although results are by no means conclusive they indicate wide differences in rates at which water may pass through the soil mantles to intermediate and deep-seepage channels and suggest the feasibility of evaluating infiltration phenomena on watersheds by a simple direct method.

Method. Briefly stated the method consists of constructing small "semi-standard" trenches confined exclusively to the A horizon or to the B horizon, and large "standard"^{1/} trenches which penetrate A and B horizon soil. At the beginning of each test sufficient water was added to each trench to provide a head of 5 inches on small trenches and 8 inches on large trenches. Water was added as absorption occurred so as to maintain constant heads. Tests were run in blocks replicated 3 times with 3 trenches in each block.

Absorption in A horizon. As shown in table 1, rate of absorption in the A horizon of Ephraim soil was about 1.5 times greater than in Parrish soil at the beginning of the tests, but at the end of the 6 hours Parrish soil was absorbing about 5 times faster than Ephraim soil. The initial high absorption in Ephraim soil is believed due to frost action in loosening the surface inch of soil, which doubtless increased the penetration rate at the beginning of the testing period, a condition which did not exist in the trenches tested at Parrish Creek.

^{1/} See ECW Forestry Publication No. 4, 1936.

INFLUENCE OF NATURAL VEGETATION ON STREAMFLOW (cont'd)

Table 1.--Absorption rate in inches of water per hour on Parrish and Ephraim watershed soils.

Elapsed time (Minutes)	A horizon ^{1/}		B horizon ^{1/}		A and B horizon ^{2/}	
	Parrish	Ephraim	Parrish	Ephraim	Parrish	Ephraim
5	16.50	23.64	13.38	4.56	11.46	10.26
10	15.60	19.32	11.46	3.96	9.00	7.68
20	14.58	13.98	9.48	3.12	6.96	5.82
40	13.59	10.32	7.32	2.16	5.22	3.66
60	13.08	8.22	6.06	1.62	4.56	2.55
120	12.45	5.28	4.05	0.84	3.84	1.38
240	11.64	3.45	2.28	0.48	3.60	0.99
360	10.98	2.10	1.86	0.36	3.42	0.66
480	10.26		1.50			0.42

^{1/} "Semistandard" trench 72 inches long, 8 inches deep, 30 inches wide (top), water surface 9 square feet when depth held constant at 5 inches.

^{2/} "Standard" trench 72 inches long, 48 inches wide (top), water surface 18 square feet when water depth held constant at 8 inches.

Absorption in B horizon. Absorption at the beginning of tests was 3 times greater in Parrish B horizon than in Ephraim B horizon soil, but after 6 hours the difference increased to about 5 times greater for Parrish soil. At the beginning of the test, Ephraim B horizon absorbed about 0.2 times as fast, and Parrish B horizon about 0.8 times as fast as their respective A horizons. After 6 hours of testing each B horizon was absorbing about 0.19 times as fast as its corresponding A horizon.

Absorption in A and B horizon. The larger trench used in this test (table 1) extended into the B horizon so that the trench bottom and about one-half of side areas exposed to water were in B horizon soil. Absorption was about equal in both soils at the beginning of tests but after 6 hours Parrish soil was absorbing about 5 times faster than Ephraim soil. B horizon was apparently limiting absorption in this test.

The significant thing about the three comparisons just made is that regardless of the kind of trench used in the test and the differences in initial absorption rates, Parrish Creek soil was absorbing about 5 times as fast as Ephraim soil and each A horizon was absorbing about 6 times as fast as its underlying B horizon after 6 hours' testing.

Giving practical application to these data one should expect the higher absorption rates in A horizons to be effective during short summer rains which do not penetrate more than a few inches into the soil, whereas B horizons would have little if any effect on absorption of summer rains but may be the major edaphic factor in controlling absorption of large quantities of melted snow water. It is not difficult to reason that an impervious B horizon may result in high flash spring runoff and low natural storage for late summer flow.

Influence of trench size. Small trenches confined to A horizon soil absorbed, on an average, more water than the larger trenches which have twice the absorbing area but which extended into the impervious B horizon soil. Considered from a practical viewpoint, this observation suggests that large trenches would function principally in holding flash runoff from melted snow such as occurs in the high mountains of the West during short periods of high mid-day temperature.

Effects of vegetation in trenches. As shown in table 2 infiltration was about 1.5 times greater in vegetated trenches than in non-vegetated trenches. Some vegetated trenches absorb water 3 times as fast as nonvegetated trenches, and all tests made of vegetated trenches showed considerably higher infiltration than nonvegetated trenches, even after 6 hours of testing. Benefit from vegetation in trenches, and possibly elsewhere also appears to result from its effect in increasing the infiltration rate of the B horizon.

Effect of trampling. At the beginning of tests soil not trampled absorbed water 1.5 times as fast, and after 6 hours 4.5 times as fast as trampled soil.

INFLUENCE OF NATURAL VEGETATION ON STREAMFLOW (cont'd)

Table 2.--Absorption rate in inches per hour on vegetated, non-vegetated, and trampled soil, Parrish watershed.

Elapsed time	Vegetated		Not vegetated		
	First run	Second run 1/	Not trampled	Trampled	
				First run	Second run 2/
(Minutes)					
5	16.62	9.24	11.76	7.56	1.98
10	15.48	8.76	10.62	6.42	1.68
20	14.04	8.16	9.06	4.86	1.20
40	12.00	7.68	7.56	3.18	1.08
60	10.56	7.50	6.84	2.46	.72
120	8.49	7.26	5.82	1.86	.60
240	7.32	6.66	5.10	1.38	.54
360	6.72	6.00	4.56	1.02	.48
480	6.18	5.46		.66	

1/ Re-run of the same block of trenches 94 hours after the first run started.

2/ Re-run of same block 72 hours after first run was started.

Rocky Mountain

A rational calibration for San Dimas flumes.--A method has been developed for calibrating San Dimas flumes on a rational basis, without the need for empirical figures except as a check on computed values.

The procedure is an adaptation of the "specific-energy" method for computing backwater and drop-down curves, as outlined by Scobey in "Flow of Water in Flumes" (USDA Tech. Bul. #393). Its advantage over empirical "rating" of flumes lies in the fact that a satisfactory calibration can be established for any one of a group of flume widths, floor slopes, and roughness factors without time-consuming laboratory or field measurements. The method should be applicable to any rectangular flume or broad-crested weir with well-rounded entrance transitions, as well as to San Dimas flumes.

The only limitation seen as yet is that the kinetic flow energy provided by the given conditions of floor slope and friction must be at least as great as the initial specific energy of the flow in the flume, including residual momentum from the transition. In practice this only means use of floor grades over 2% for very smooth flumes (Kutter's "n" = 0.010 - 0.011); over 3% for the roughness of good concrete ("n" = 0.013); and over 5% for rougher conditions ("n" = 0.015 - 0.017).

Summarized briefly, the method consists of computing drop-down curves for at least four discharges under the desired flume conditions. The starting point of each curve is the computed "critical" depth, assumed to fall on a line with its origin on the upstream end of the flume floor, and sloping downstream at an angle of 10° from the vertical.

From the plotted surface curves, a depth corresponding to each discharge may be scaled off (vertically) at the desired point of measurement. This point should be taken in a zone where pressures and depths may be expected to show close agreement; near the longitudinal center of the flume.

The stage-discharge relation for the flume in question may be determined either by plotting or by fitting a formula by least squares.

The proposed method has been checked against actual model-flume data obtained at the California Forest and Range Experiment Station, using several different floor slopes and friction factors. The average deviation of computed from observed depths was less than one percent.

Analysis of 1938 and 1939 snow accumulation data. Analysis of two years' snow data as observed at 500 snow stakes in lodgepole pine on the Fraser Experimental Forest shows that: (1) a highly significant relation exists between canopy densities, size of canopy openings, and the amount of accumulated snow in the spring; (2) the amount of accumulated snow (expressed as inches of water) steadily increases from a minimum at a point 26 feet inside the canopy edge to a maximum at a point 30 feet in the open; (3) in this particular study the amount of snow was not affected by exposure, slope percent, length of slope, or position on slope.

Silvicultural cuttings now being made in the lodgepole pine stands will increase the size of canopy openings. Future observations and analysis should, therefore, demonstrate the relationship of openings in excess of 60 feet in diameter to the amount of snow accumulated in such openings. It is anticipated that an optimum opening size will be found, beyond which there is no increase in snow storage.

Southern

Springflow study. Last fall a spring near the headquarters was developed to provide a continuous record of flow throughout the year. Although the spring has provided drinking water for cattle and motorists for a great number of years, it has dried up during the month of August for the past two years. To provide year-round flow a pit was excavated almost to solid rock, a slab of concrete was poured in the bottom leaving only a hole in which about 6 feet of tile was set and tight clay was tamped over the concrete slab and around the tile. A concrete weir box was constructed around the tile so that water flowing up through the tile would spill over a 90° V-notch weir. A water level recorder over the weir box gives a record of springflow. Water flowing over the weir also runs through an approach flume to a 6-inch San Dimas flume. Wing walls extend out from the approach flume diverting seepage water and ground water, not confined by the concrete slab, to the San Dimas flume, thus augmenting springflow. Following a dry period in December, a rain of 2.56 inches resulted in an increase of 40 percent in ground-water flow while seepage, absent prior to the rain, increased to 34 percent of the ground-water flow. This seepage is collected at a depth of 3 feet below ground level and just above a layer of white clay.

Southwestern

Flow in Salt River very low. Flow in Salt River has been extremely low during the past summer and fall and so far during the winter season. Practically all of the flow has been diverted at the Intake Dam and carried through the power canal to the top of Roosevelt Dam, where it passes through the turbines to generate hydroelectric power for the large copper mines at Miami. By agreement with the State Game and Fish Commission, the Salt River Valley Water Users' Association has retained about 2,500 acre-feet of water in Roosevelt Reservoir to prevent further loss of game fish. The Game Department has removed about 300 tons of carp from the lake during the past year.

Total water stored in the four reservoirs on Salt River amounts to only 128,249 acre-feet, as compared to 258,498 acre-feet a year ago. An additional 1,047 acre-feet is stored above the recently completed Bartlett Dam on the Verde River. These five reservoirs, with a total storage capacity of 1,996,800 acre-feet when filled, hold sufficient water to carry the Salt River Project through several years of low flow.

Much depends on the amount, distribution, and character of snowfall and rainfall during the coming 4 months, as little increase in storage can be expected after June 1. The soil mantle is still

INFLUENCE OF NATURAL VEGETATION ON STREAMFLOW (cont'd)

fairly well filled with moisture from rains of late December and early January, but if more rain or snow does not fall soon, much of this moisture will evaporate and more rain or snow water will be required to replenish the moisture so lost. Therefore, the time at which precipitation comes has a decided influence on stream flow. For example, a much larger flow could be expected from a 2-inch rain at this time than from a similar amount of rainfall coming after several weeks of dry weather.

The winter has been extremely mild until January 15, and temperatures have been considerably above normal. Manzanitas in chaparral areas on the Tonto and Crook National Forests were in full bloom on New Year's Day.

Workman Creek Lysimeters. A battery of six lysimeters, consisting of natural soil blocks with a surface area of 1,000 square inches and 28 inches in depth, have been installed on the upper Workman Creek watershed. These lysimeters are representative of bare, litter-covered, and herb-and-grass-covered ground of high, forested areas; all are on a slope of 10 percent. Throughout each soil block, the texture of the heavy loam soil appears to be quite uniform.

About 1 inch of snow remained on the lysimeters at the time first measurements of percolation were taken on January 12. Between that time and January 15, an average of 0.32+ inch of percolation has been recorded. Individual readings are as follows:

Date of measurement	Bare lysimeters no vegetation or litter		Litter-covered lysimeters (pine and oak litter)		Vegetated lysimeters (herbs and grasses)	
	Percolation No. 1	In. ^o No. 2	Percolation No. 3	In. No. 4	Percolation No. 5	In. No. 6
1940						
Jan. 12	.10	.10	.09	.15	.12	.10
Jan. 13	.08	.08	.07	.08	.08	.08
Jan. 14	.08	.07	.07	.08	.08	.08
Jan. 15	.06	.06	.06	.06	.06	.07
Total	.32	.31	.29	.37	.34	.33

^oInches over lysimeter areas.

These preliminary results are of interest as they indicate that the soil is well filled with moisture to a depth of 28 inches and more rainfall or melting snow at this time would result in high yield of percolation water.

Precipitation on Workman Creek experimental watershed. A battery of five shielded storage gages designed by the U. S. Weather Bureau to obtain accurate measurements on snowfall was installed on the Workman Creek 1,087-acre experimental watershed in the fall of 1938.

INFLUENCE OF NATURAL VEGETATION ON STREAMFLOW (cont'd)

These gages are located near the center of the watershed in an opening in pine-fir forest and at an elevation of 6,910 feet. Four of the gages are so located as to form the corners of a rectangle having sides about 300 feet in length. The fifth gage is in the center of the rectangle where the two diagonals intercept. The rain and snow collectors are on steel towers 9 feet tall, high enough to always be above the general snow level. Each collector consists of a can 8 inches in diameter with open top, and has a film of oil added to prevent evaporation. Calcium chloride solution is added to melt the snow as it falls and prevent freezing of precipitation water and damage to the container. The gages are equipped with circular shields comprised of thin strips of galvanized iron metal which are designed to reduce swirling of wind currents around the collectors. After each storm the containers are weighed on spring balances which are graduated in inches of rainfall.

The division of winter and summer precipitation so far at Workman Creek is similar to that of the longer record at Parker Creek, 1,800 feet lower in elevation, about 60 percent for the winter period and 40 percent for the summer. Precipitation amounted to 19.40 inches for the winter period October 1, 1938, to May 31, 1939, and 12.88 inches for June 1 to September 30, 1939. Precipitation for the year of 1939 was 33.75 inches at Workman Creek, as compared to 25.50 inches at Parker Creek.

Differences in yearly precipitation catch between high and low gages amounted to 1.02 inches; however, the deviations from the average, as shown in the following table, are not exceptional for the amount of precipitation involved.

Winter Period						
	Gage No.1 NW corner	Gage No.2 NE corner	Gage No.3 Center	Gage No.4 SW corner	Gage No.5 SE corner	Average
Seasonal precipitation in inches	19.16	18.79	19.58	19.86	19.61	19.40
Differences above or below ave. in inches	-.24	-.61	+.18	+.46	+.21	
Summer Period						
Seasonal precipitation in inches	12.82	12.84	12.74	13.04	12.94	12.88
Differences above or below ave. in inches	-.06	-.02	-.14	+.16	+.06	

STABILIZATION OF SOILS

California

Watersheds

Flood Control Measures, Fern Canyon. The program of soil stabilization on the area burned during November 1938, in the headwaters of the San Dimas drainage, has been carried forward with the completion of several barriers in Fern Watershed No. One and the adjacent drainage designated as Fern No. Zero.

Several types of experimental barriers have been constructed in the channel of Fern Watershed No. One to test their adaptability for use in small drainages. Twenty have been constructed in this watershed to date, including five wet masonry, three dry masonry, eleven sack (filled with earth and cement), and one timber barrier. These were filled to approximately 90 percent of their total capacity during the recent storms. In Fern Zero channel, eleven larger masonry barriers have been completed and all but two have been entirely filled with debris resulting from the September 1939 and January 1940 storms.

Roads

Soil stabilization work on approximately three miles of road within the burned area has involved the installation of culverts and other needed drainage facilities, and the construction of some thirty masonry toe walls to prevent excessive erosion from overcast slopes. Wattling of these slopes is now in progress, to be followed by the planting of several species of native shrubs to test their adaptability for erosion control.-- J. D. Sinclair, Silviculturist.

Southern

Watersheds

Irons Fork Creek. The Irons Fork Creek dam which was started last summer has been completed. It is an earth fill dam with a clay core, is 7 feet high, 100 feet long and will impound approximately 1-1/4 acre-feet of stormflow from a drainage area of 110 acres. A 12"x12" concrete outlet was constructed through the base of the dam and provision was made for drop gates at each end of the outlet with which to regulate the discharge and thus maintain storage capacity of the structure. To provide a record of the watershed discharge, a 1-foot Parshall flume was installed at the end of the outlet flume and

STABILIZATION OF SOILS (cont'd)

a staff gage will be placed in the reservoir. Although the clay core extends to a depth of 4 feet below the channel bed, there has been no surface channel flow into the reservoir since last spring. However surface channel flow occurs 100 feet below the dam and plans call for its measurement by regular stream-gaging methods.

This dam is considerably larger than any other yet undertaken on the Irons Fork and will provide a test for applicability of similar-sized dams as headwater control structures for reduction of peak flows in the Ouachita Mountain region.

RANGE RESEARCH

ARTIFICIAL REVEGETATION

Intermountain

Site Factors

Suppression of Reseeded Grass Seedlings by Sagebrush. The extent to which an established stand of sagebrush may interfere with the establishment and spread of reseeded grasses is indicated by measurements made on pairs of burned and unburned plots in a heavy sagebrush stand at Clover Creek, Nevada. Ten pairs of 1/100-acre plots were laid out at the edge of an area burned in August 1937 and were seeded that fall. Seeding was done by broadcasting with no attempt at covering, since it was felt that uniform covering on the burned and unburned plots would be extremely difficult. At the end of the second growing season, in May 1939, quantitative measurements were made with the results as shown in the following table.

ARTIFICIAL REVEGETATION (cont'd)

Number of established reseeded grass plants and calculated weight of herbage produced by reseeded species on pairs burned and unburned plots.

Seeded Species	Block Number	Number of Plants		Calculated green weight of herbage per plot (grams) ^{1/}	
		Unburned	Burned	Unburned	Burned
<u>Agropyron cristatum</u> (15 lbs. per acre)	1	38	95	152	475
	2	19	131	38	1,048
	3	123	143	98	2,145
	5	48	53	48	477
	6	160	72	168	1,584
Means	-	79.2	98.8	100.8	1,145.8
<u>Bromus inermis</u> (25 lbs. per acre)	3	26	91	26	1,092
	5	16	73	16	1,533
	6	25	107	25	3,210
Means	-	22.3	90.3	22.3	1,945.0
Mixture ^{2/}	1	17	150	68	900
	2	26	69	78	621
Means	-	21.5	109.5	73.0	760.5
Grand Means	-	50.6	98.4	71.7	1,308.5

1/ Determined by multiplying the number of plants per plot by the average weight of 10 representative plants taken from each plot.

2/ Agropyron cristatum 4 lbs., A. inermis and A. spicatum 2 lbs., A. smithii 1 lb., A. pauciflorum 1 lb., Arrhenatherum elatius 1 lb., Bromus inermis 2 lbs., Festuca ovina 0.5 lb., Poa bulbosa 0.2 lb., and Rye 10 lbs.

Although there were less than twice as many plants on the burned as on the unburned plots, the herbage production was more than 18 times greater on the burned plots. Because of the seeds not being covered, the number of plants established was in no case adequate for a full stand. It is significant, however, that the plants that did become established in the unburned plots have made very little growth, the production of forage per plant being only about one-seventh as great as that on the burned plots.

This study indicates clearly that sagebrush suppressed the growth of reseeded grasses and that the removal of sage brush will favor the development of a satisfactory stand. In order that a fuller understanding

of the competition may be reached and some prediction as to the eventual balance between grass and sagebrush may be attempted, additional studies of the nature of the suppression are contemplated.

Species

Distribution Study. Because of knowledge of present distribution and recent migrations of a few species, there is reason to believe that many of the less mobile species have had insufficient time since the last major climatic change to cross all of the barriers of the region and fully occupy their potential ranges. In order that artificial reseeding of native species may be more adequately planned, a preliminary study of the known distribution of species having potential value for range and watershed revegetation has been initiated.

Use is being made of the various herbaria within the region, as well as of range surveys and personal knowledge of range men who are thoroughly familiar with the vegetation in various parts of the region. Some field work will doubtless be necessary. Finally, it is planned to delimit, wherever possible, areas where the absence of particular species suggest this is apparently due to isolation. Promising species may then be introduced into these areas, first by means of nursery plots, and later where these are successful, by large-scale planting.

Northern Rocky Mountain

Species

Adaptation tests plantings of 103 forage species, varieties, or strains were made in the fall of 1938 or the following spring at one or more of our three work centers or forage nurseries. Near Missoula 95 species, Miles City 49 species, Vigilante Forage Nursery 72 species were planted. In the fall of 1939, 36 selected species were planted at Thompson Falls. Preliminary results from the foregoing follow:

1. Five species, three of them new to us, showed up especially well at Missoula on unweeded plots. Nine other species were very promising, six on fall and three on spring seeded plots.
2. Fall seeded plots produced best average stands of grasses at Missoula (3,600 feet elevation), but spring plantings were best at Vigilante (6,200 feet elevation). Results at Miles City indeterminate.

3. Best initial stands of legumes on spring seeded plots at all nurseries.
4. No legume found to date that can be as readily established on dry land areas as several of our grasses. Further search to be stressed.
5. Weeds appeared slightly beneficial to stand in early part of growing season at Rattlesnake Creek, but definitely detrimental later in the summer.
6. Considerable variability noted in the date of planting that produced the best stand with different species.

Comparative Value of Crested Wheatgrass Range. A preliminary test was made at Miles City last spring to compare the grazing value of crested wheatgrass with a nearby native range area. The yearling steers utilized the nearly pure stand of crested wheatgrass to a satisfactory degree and gained through most of May and June at the rate of 1.43 pounds per day as compared to 1.71 pounds per day for similar steers on the native-bluestem, grama, buffalo, Sandberg bluegrass range. When converted to a per acre basis, the gains on crested wheatgrass were 29.87 pounds as compared to 12.85 pounds per acre on native range. These results are indicative but further tests are now possible and will be necessary before reliable conclusions will be possible from such a comparison.

GRAZING MANAGEMENT

California

Ponderosa Pine Ranges

A Short-cut in Obtaining Forage Yield by Clipping. The large number of samples usually required to determine the yield of vegetation by species in a pasture or other range unit has prompted the use of short cuts in procedure wherever they have been possible. At the Burgess Spring area, Blacks Mountain Branch, forage yield was determined by counting the number of plants by species on quadrats and then determining the average weight of each species by clipping and adequate sample off the quadrats and applying these weights to the quadrats. This method was tried as a substitute for the time-consuming job of actually clipping the forage from each quadrat. This method has the merit of leaving the vegetation on the quadrats undisturbed

which is very desirable when certain comparisons are being made, such as between years. Sampling error between years is eliminated. Figures obtained by using this procedure are now being worked up.

In making the field counts a large variation in size of plant was noted for certain species and furthermore it was seen that a mistake in count could easily be made by overlooking small plants. Since the total weight of the species on the quadrat was to be determined by multiplying the count by the average weight of the species the error in total weight was as great when a small plant was overlooked as when a large one was overlooked. To minimize such errors records were made by large and small plants for the required species. The division between the two classes was set up arbitrarily. By this means even if mistakes were made in counting the small plants the total weights of the species on the quadrat would be affected only by an amount equal to the product of the error in count times the average weight of small plants.

The figures show that this stratification into large and small also results in a saving of time in clipping the forage. This is illustrated by figures on the dominant bunch grass of the area, Festuca idahoensis. If no distinction is made between large and small plants in the counts and in collecting a random sample for determining the average weight of the plant, 469 clippings are needed for a given reliability of the mean ($36\bar{M} = 20\%$). If the species is stratified, 262 large plants and $\frac{36\bar{M}}{M}$ small plants or a total of 373 clippings will give the same reliability in the mean. A twenty percent saving in clipping time is thus effected. This is cited as another application of stratification in sampling which is proving so valuable in many lines of research work.

--A. L. Hormay, Assistant Forest Ecologist.

Intermountain

Spring-fall Ranges

Calculating sheep-unit days feed. All classes of sheep in the Intermountain region at one time or another, use the sagebrush-grass spring-fall range. These herds of ewes with lambs of varying ages, pregnant ewes, dry ewes, yearling ewes, ewe lambs, and rams utilize the forage and we in our own crude way express the forage produced in sheep-days or sheep-months of feed. It is obvious that sheep-months forage secured by a herd of ewes with 20- to 40-pound lambs would be much different than that harvested by a herd of dry and yearling ewes. The exact extent of this difference and our ability to utilize such information in allotting range to different herds are questions the answers to which are elusive.

By utilizing the meager data that are available on sheep feeding standards, a table of sheep-unit requirement for a day's feed was compiled, showing the relative requirements of various classes of sheep in terms of a 120-pound ewe, nursing an 8- to 20-pound lamb. These requirements were compiled primarily for use in equalizing grazing records from the main herded range at the U. S. Sheep Experiment Station. Most of the data used were taken from Morrison (1). Values for classes not treated by Morrison were inserted on the basis of experience. The entire table was then reviewed by members of the Bureau of Animal Industry staff at the U. S. Sheep Experiment Station, Dubois, Idaho. The total digestible nutrient requirements presented are for animals in feedlot and as such may be fully 20 percent low for range animals that are grazing on succulent forage, Woodman et al. (2).

At best these requirements are approximate and it is hoped they will stimulate some comment and discussion concerning the methods of expressing forage production of range pastures. It would be highly desirable to express the requirements on a still more refined basis, whereby allowances are made for gains or losses, and for the extent of wool and lamb production, but only very limited data are available for sheep regarding the maintenance and production requirements and those that are available are for fattening animals, Woodman et.al. (3). The requirements for ewe nursing lambs are the total for ewe and lamb.

Factors for use in converting grazing records to sheep-unit feed days, segregated by general classes of animals that use the spring and fall range areas.

I. Dry ewes on spring range gaining slightly

Weight class (pounds)	Average total digestible nutrient requirement (pounds)	Requirements in units of a 120-pound ewe nursing an 8- to 20-pound lamb
100	1.65	0.62
110	1.75	.66
120	1.85	.70
130	1.95	.74
140	2.05	.77
150	2.20	.83

II. Mature rams on spring range gaining slightly

160	2.25	0.85
180	2.45	.92
200	2.60	.98

GRAZING MANAGEMENT (cont'd)

	Weight class (pounds)	Average total digestible nutrient requirement (pounds)	Requirements in units of a 120-pound ewe nursing an 8- to 20-pound lamb
III.	<u>Ewe nursing an 8-20# lamb on spring range, maintaining her own weight</u>		
	100	2.45	0.92
	110	2.55	.96
	120	2.65	1.00
	130	2.75	1.04
	140	2.85	1.08
	150	2.95	1.11
IV.	<u>Ewe nursing a 20-40# lamb on spring range, maintaining her own weight</u>		
		<u>1/</u>	
	100	2.70	1.02
	110	2.80	1.06
	120	2.90	1.09
	130	3.00	1.13
	140	3.10	1.17
	150	3.20	1.21
V.	<u>Ewe nursing a 40-60# lamb, maintaining her own weight</u>		
	100	3.05	1.15
	110	3.15	1.19
	120	3.25	1.23
	130	3.25	1.26
	140	3.45	1.30
	150	3.55	1.34
VI.	<u>Dry ewes on fall range gaining slightly or maintaining weight</u>		
	100	1.65	0.62
	110	1.75	.66
	120	1.85	.70
	130	1.95	.74
	140	2.05	.77
	150	2.20	.83

Weight class (pounds)	Average total digestible nutrient requirement (pounds)	Requirements in units of a 120-pound ewe nursing an 8- to 20-pound lamb
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VII. Ewe lambs on fall range, gaining in size but not fattening

50	1.05	0.40
60	1.35	.51
70	1.55	.58
80	1.65	.62
90	1.75	.66

1/ Computed to equal ewe requirements plus lamb requirements. Lamb requirements were estimated to be secured 75 percent from the ewe and 25 percent from the range directly.

It is interesting, and perhaps a bit disconcerting, to note the great difference in the requirements of a 120-pound dry ewe, a 120-pound ewe nursing an 8- to 20-pound lamb, and a 120-pound ewe nursing a 40- to 60-pound lamb. In view of these differences, it is small wonder that forage-acre requirements scatter widely.

- (1) Morrison, F. B. Feeds and feeding. 20th Edition. 1936.
- (2) Woodman, H. E., Evans, R. E., and Edon, A. Sheep nutrition. I. Measurements of the appetites of sheep on typical winter rations, together with a critical study of sheep-feeding standards. Jour. Agr. Sci. 27:191-212.
- (3) Woodman, H. E., Evans, R. E., and Edon, A. Sheep nutrition. II Determinations of the amounts of grass consumed by sheep on pasturage of varying quality. Jour. Agr. Sci. 27: 212-224.

Spring-fall Range

Climate and the success of sagebrush removal by fire. In 1936, a more or less crude plan of studying the relation of climate to the success of big sagebrush (*Artemisia tridentata*) removal by fire, was initiated on the U. S. Sheep Experiment Station range. Provision was made to remove sagebrush from at least 640 acres of range each year, over at least a 10-year period. Burns from 1932 to this date in Clark and Fremont Counties had indicated that where sufficient grass occupied the area before sagebrush was burned and where the proper grazing practices were used after burning that almost universal success

was achieved. On most of these old burns sagebrush seedlings had not yet begun to return 5 years after the fire.

Despite these early indications the demonstration at the Sheep Station begins to portray some real difficulties. The area burned in 1936 is still almost entirely free of any sagebrush seedlings. But, the area burned in 1937 shows a very different tendency, even though the area appeared to have a satisfactory amount of perennial grass before burning and was given a year's protection from grazing after burning.

The 1,000 acres burned in 1937 was sampled in the fall of 1939, using 6 randomly located line-plots, each composed of ten 50-square-foot plots spaced at 8-chain intervals, to determine the stocking of sagebrush seedlings present on the area. A similar number of line plots were located in adjacent unburned areas to determine the number of sagebrush plants that made up a mature stand. In each 50-square-foot plot the number of seedlings was counted, an estimate made of their average height as being indicative of vigor, and the stand of perennial grass on the area classified in one of three categories - sparse, moderate, and abundant.

The uniformity of the seedlings over the entire 1,000 acres seems to indicate that they arose from seed stored in the soil before the fire. Seedlings from wind-disseminated seed would have been much more abundant near the unburned areas and this was not the case. Since the area was burned in August 1937, before the sagebrush bloomed that year, this must have been 1936 sagebrush seed and some peculiarities of the spring of 1937 did not permit germination of the seed, as is the normal procedure. Then it must again be assumed that the fire did not damage the seed, even though it was one of the most intense fires that has been seen in this locality. We know so little of the characteristics and seed habits of sagebrush that it is necessary to make assumptions but the occurrence of sagebrush seed years and the failure to germinate are both traceable as manifestations of climate.

Data on the vigor and number of seedlings occurring in plots with different stands of perennial grass are shown in the following table:

Number and average height of big sagebrush seedlings per plot of 50 square foot area located in different stands of perennial grass.

Abundance of grass	Number of sagebrush seedlings	Average height of sagebrush seedlings
		(inches)
Sparse stand 10	17	2.7
Moderate stand 25	16	1.8
Heavy stand 25	6	1.0

The number and vigor (average height) of sagebrush seedlings is seen to be directly related to the abundance of perennial grass. There is but little doubt that had records been secured in the spring of 1938 after the sagebrush seedlings came up that, barring variations in seed distribution, there might have been nearly the same number of seedlings on each of the types of plots. The stand of grass may have been largely effective in the reduction of the number of sagebrush seedlings through competition. This appears to be true from the average height of the seedlings in the three classes.

The following data are presented on the number of sagebrush seedlings on the burn and the number of sagebrush plants in a mature stand, per plot 50 square feet in area.

Number of sagebrush seedlings on burn per plot - 11.8

Number of sagebrush plants in mature stand, per plot - 12.1

This comparison shows the number to be about the same under each condition. In other words, if all of the seedlings present on the burn develop into mature plants there will again be an impenetrable stand of sagebrush on this area 10 to 12 years hence. Management must be of such character as to allow the perennial grasses to grow and reproduce to crowd out the sagebrush seedlings if sagebrush removal is to be permanently effective. What the requirements of management are for this purpose are not known, but total protection from grazing is to be given in the area during the spring of 1940.

This occurrence adds to the already extensive list of variables affecting the success of sagebrush removal by fire. It seems clear that the occurrence of sagebrush seed years and the occurrence of conditions unfavorable to sagebrush seed germination the following spring must be considered.

Northern Rocky Mountain

Shortgrass Ranges

Utilization Measurements. During the past three seasons, considerable time has been spent in an effort to develop a method for measuring varying degrees of range utilization in an objective manner. Various leads have been followed only to find some obstacle that was seemingly fatal to a good method. During the past year results of some promise have been obtained in testing a method on both cattle and sheep ranges. Utilization on sheep range was extremely varied and results there are not quite so satisfactory as on cattle ranges but are none the less encouraging.

Briefly, the method is based on measurements of stubble heights and the percent of ungrazed plants of key species at stations located along a grid of transect lines. From these values utilization is computed for key species, types, and pastures. A volume curve constructed for each key species is used in one step of this computation. In the case of cattle range, a good correlation was found between utilization of winter pastures grazed at three intensities and the weight gains of cows during the first month after they were removed from utilized pastures to fresh range with an abundance of feed. The following tabulation shows the percent utilization for the Lone Pine winter pastures based on four key species combined and on bluestem wheatgrass alone, also the initial gains of cows on fresh range.

Intensity of Use Pastures	Percent utilization winter pastures in 1939		Average spring cow gains first 28-days at summer pastures
	Using 4 key Species	Bluestem alone	
Overgrazed	55	55	69 pounds
Moderately grazed	46	49	56 "
Lightly grazed	42	37	38 "

The sequence and order of these utilization figures rather than the actual percentage figures are matters of chief interest at this time. Another indication that the method used actually measures comparatively slight variation in utilization is given when utilization percentages are arranged in accordance with distance on radii out from the central well. These percentages are as follows for the four key species in all pastures (three intensities represented): 68, 60, 54, 51, 47, 46, 43, 36, 33, and 18. Thus, utilization decreases as distance from well increases. Generally speaking, those differences are not perceptible by observation. This, together with the fact that the differences are very consistent, appears to justify a hopeful view at least of the possibilities when the method is better developed. At present it is too time consuming for use as an administrative tool, but a comparison of results with varying numbers of samples indicates that fewer samples will give values closely approaching those for more samples. Considerable ingenuity will be required to refine the method for general use where time is very limited.

Pacific NorthwestSummer Range

Losses in resource value of green fescue range resulting from soil erosion and from overgrazing are presented in the following table:

Range condition	Soil loss per acre (tons)	Grasses		Green fescue		Grazing capacity (sheep) months per acre)
		Density	Percent composition	Density	Percent of grass density	
Undisturbed	2	31.7	67.9	31.7	100.0	5.4
51-75% topsoil uneroded	212	8.7	50.3	3.7	42.5	1.0
26-50% " "	357	6.4	44.1	3.1	48.4	0.9
1-25% " "	606	3.6	35.3	1.3	36.1	0.4
0-1% " "	926	1.5	19.2	0.1	6.7	0.2

These averages were obtained by sampling a 690-acre area of green fescue range in the Wallowa Mountains in Oregon. The eroded range is located in Tenderfoot Basin at the head of the North Fork of the Kanana River. The undisturbed range is located but 2 miles from the eroded area and on a similar site. It is the best indication available of original green fescue range condition.

The soil loss on Tenderfoot Basin due to overgrazing is rather staggering; from 100 to 463 times as much as that from normal erosion. Average soil loss in Tenderfoot Basin is 440 tons per acre or 220 times the normal figure.

Grasses on undisturbed range cover nearly one-third of the ground surface, form two-thirds of the plant cover, and are 100 percent green fescue. As erosion grows progressively more serious, it will be noted that grass density is lower, the proportion of grass to other vegetation is also lower, and the proportion of green fescue to other grasses is much reduced.

Accelerated erosion and type retrogression effects are summed up in the grazing capacity estimate obtained by range survey methods: undisturbed range - 5.4 sheep months per acre; range with topsoil completely eroded - 0.2 sheep month per acre. This is a loss of 96 percent. Estimated average grazing capacity of Tenderfoot Basin range is 0.6 sheep month per acre, a loss of 89 percent of the original grazing value.

GRAZING MANAGEMENT (cont'd)

History bears out the dependability of the grazing capacity estimates in a substantial measure. In 1916, approximately 14,400 sheep months use was obtained from the range in Tenderfoot Basin. In 1938, 1,500 sheep months of use fully, if not over, utilized it. This very tangible loss amounts to 90 percent of the 1916 value and confirms the theory that fertile topsoil pouring off a mountain is not just so much "water under the bridge."

Rocky Mountain

Shortgrass Ranges

Age vs. gain of range cattle. The weights and gains for 153 yearling heifers grazed on the Central Plains Experimental Range from May 1 to September 1, 1939, indicate a close relationship between age and rate of gain.

Approximate age (months)	Initial weight (May 1)	Final weight (Sept.1)	Gain	
			Pounds	Percent of initial weight
9	280	424	144	51.4
9	300	482	182	60.6
10	320	522	202	63.1
11	340	554	214	62.9
11	360	582	222	61.6
12	380	606	226	59.4
12	400	628	228	57.0
13	420	648	228	54.2
13	440	664	224	50.9
14	460	678	218	47.3
14	480	688	208	43.3
15	500	694	194	38.8
16	520	704	184	35.3
17	540	710	170	31.4
18	560	716	156	27.8

It is worthy of note that animals averaging 400 to 420 pounds initial weight made the greatest total gain during the summer. The percent of gain, however, decreased consistently after the heifers had passed the age of 10 months. Although these figures are tentative, being based on only one season's observations, they indicate that the rancher can feed grass more economically to yearlings than to two-year old cattle. It is true that a larger percentage of two-year olds will sell as grass-fat animals and demand slightly higher market prices, but the yearlings will in many instances give better cuts for the consumer. Conclusions in this regard, however, are reserved until further study has been made and additional cattle weights are available.

From the research point of view, the table shown above demands consideration. When cattle gains in pastures receiving different treatments are compared, it is highly essential that the variation due to different age and weight classes of animals be removed before variations in gain between pastures are ascribed to the treatment.

Key species of the forage types of Colorado and Wyoming. It is generally recognized that plants, if properly interpreted, may be used as indicators of soil type, climatic conditions, processes such as succession, range conditions, and degree of use by grazing animals. In recent range surveys and forage inventories in Colorado and Wyoming more than 2000 plant species have been encountered. In order to narrow the field and determine which of these 2000 species are the important plants, or key species in each forage type, a score card system similar to that used in judging livestock has been used.

Key species are the important plants in each forage type. They are the plants which must be considered in proper management of any area. They may be important because of their abundance, forage value, influence on watershed conditions, poisonous properties, or usefulness in determining degrees of grazing. They may be used as utilization indicators (particularly grasses); in determining proper class of stock, opening and closing dates, season of use; and in judging range conditions and range potentiality.

In the selection of key species by the score card system the following criteria were used: density (ground cover), percentage composition in the type, and palatability; frequency of occurrence or abundance; and geographic distribution or extent of occurrence. Consideration of all these factors indicates that a plant may be a "key species" even though it does not possess high palatability or produce a maximum amount of forage on the range.

When key species are rated by the score card method in order of descending importance for forage types, national forests, counties, or similar units, some unexpected results are obtained. For example, the importance of sedges on the national forests is emphasized. Dandelion, western yarrow, and cinquefoil in numerous instances take higher rank than grasses, owing to their wide distribution, frequency of occurrence, and even the amount of forage produced. These plants, and such dominant species as big sagebrush and Gambel oak, or poisonous plants of wide occurrence such as orange sneezeweed become key species. They must be considered in any program of range management dealing with areas where they occur.

The present effort of determining what are the key species in the forage types of Colorado and Wyoming is basic to a further study of what these species indicate and how their indicator values may be

used to greatest advantage. Present knowledge is not sufficiently advanced to permit an interpretation of the meaning of the presence and the physiological condition of every plant in an ecological community. The first step has been taken, however, in that the most important indicators have been segregated for study from the large number of species which are invariably encountered in the field.

Noxious Plant Control

Sheep management discussed with woolgrowers. The results and recommendations derived from a study of range infested with orange sneezeweed have been discussed recently with the woolgrowers of western Colorado. At each annual meeting of the various associations of woolgrowers Cassady has presented an illustrated lecture outlining the ecology and life history of sneezeweed, methods of eradication and methods of managing sheep on infested ranges. This series of lectures will close very shortly, at which time nearly every prominent woolgrower in western Colorado will be acquainted with the studies being conducted on the sneezeweed problem.

Southwestern

Noxious Plant Control

Mesquite. Velvet mesquite (Prosopis velutina) in spite of its many values has come to be regarded as a noxious tree or shrub in many localities of the Southwest. The problem of control involves both trees and stumps since the latter sprout profusely whenever cut. Data collected in November on stumps and trees treated by various eradication methods during 1938 and 1939, table 1, substantiate observations made in an earlier bi-monthly report (April 1939, p.81). These were to the effect that kerosene or diesel oil are ineffective in killing either mesquite trees or stumps, at least under Arizona conditions, and that studies on the control of mesquite at the Santa Rita Experimental Range indicate the need for more specific information on treatments which are not only effective in killing the plant but economical in application. None of the treatments were effective in killing mesquite stumps or trees, if a 90-percent kill or better is considered as being effective.

Although the early results of the early treatment are largely negative, methods used during the latter part of the 1939 field season, the final results of which are not yet available, offer considerable promise. It should be noted that several treatments caused immediate defoliation and other evidence of necrosis, but in many instances check observations at a later date showed evidence of living tissues, and in many instances vigorous sprouts appeared on trees which had been originally marked as being dead.

These preliminary investigations on mesquite eradication indicate that:

1. Kerosene or diesel oil cannot be recommended for use under Arizona conditions. However, there is the possibility that they may be used in combination with some other treatment. For example, scorching the base of the tree with a flame gun for a period of 2 minutes might be followed 15 days later with a spray of diesel oil which would saturate the stem base and kill the regrowth.

2. The Cornell tree killing tool^{1/} should yield effective kills if care is taken to completely girdle the tree as close to the soil surface as is possible. A solution containing two pounds of white arsenic (AS_2O_3) per gallon has been used, but stronger solutions up to eight pounds arsenite per gallon should be tested. The tool is difficult to use on low hanging trees or shrubs.

3. The basin method whereby a small basin or trench is dug around the base of the stem and 200 cc of sodium arsenite solution (2.5 lb. per gallon of water) diluted with 800 cc of water are poured into the basin appears to be effective on trees up to 5 inches in diameter. On 20 trees (#671-690, table 2) an 85-percent kill was obtained. Leaves were gathered from these trees 20 days following treatment and analysis showed 125-150 ppm. of arsenic (AS_2O_3). The possibility that these might cause poisoning if eaten by livestock is being investigated.

The methods described briefly above will be used as the basis for a new series of treatments for application during the year 1940.

Yearlong ranges

Jornada Forage Production and Utilization Study. The forage inventory of the grama forage study enclosure for the grazing year 1939 (includes summer growing season of 1938) was made over a period extending from November 18 to December 1, 1938. The inventory was made by harvesting samples of the forage from plots selected by a system which insured complete randomization of the plots used inside the 160-acre enclosure. These plots or transects composed of two sets of 64 each and were labeled A, forage inventory plots, and B, utilization plots. Forage from the A set was clipped at ground level before stocking the enclosure and the air-dried samples used to compute the amount of forage produced during the current growing season within the enclosure. The B set was clipped after use of the area by grazing cattle.

^{1/} The Killing of Trees with Sodium Arsenite. By J. A. Cope and J. N. Spaeth, 1931. Jour. of Forestry Vol. XXIX, No. 5, pp. 775-783.

On January 24, 48 cows and 2 bulls were placed in the enclosure. The cattle were weighed at the time, and they averaged in weight 757.4 pounds each. After grazing the enclosure for a period of 41 days, or until March 6, the cattle were judged to have properly used the area according to the Jornada concept of proper use. The cattle were thereupon removed and again weighed. At this time they registered a loss in weight of 46 pounds per head or an average weight of 711.4 each. This loss in weight was characteristic of the general shrinkage of all the cattle on the range at this time and was due to the unusually cold, windy weather experienced during all of the early spring and to the lack of early feed growth such as weeds and other annuals because of the low temperatures.

After cattle were removed, the B (utilization) plots were selected and clipped using the same method of selection as in the A plots. As in the inventory plots, the grass was allowed to dry thoroughly after clipping, this requiring from 2 to 3 weeks in order to secure moisture-free weights. The weight of the material clipped from the B plots determined the amount of forage left after the area has been properly utilized and from which is calculated the weight of forage which has been used by the grazing animals.

The 1939 grazing year forage inventory as shown by samples obtained from the A transect and the amount of herbage remaining after the pasture was grazed is shown in table 1.

Table 1. Herbage produced and herbage remaining at end of grazing season (1938-1939) in 160-acre pasture.

Species	A Plots (Herbage produced)			B Plots (Herbage remaining)		
	Yield per plot	Estimated total yield - 160 acres	Total forage	Yield per plot	Estimated total yield - 160 acres	Total forage
	<u>Grams</u>	<u>Pounds</u>	<u>Percent</u>	<u>Grams</u>	<u>Pounds</u>	<u>Percent</u>
Black grama	224.59	68,923	62.2	96.82	29,720	58.5
Other grasses	136.30	41,848	37.8	68.69	21,092	41.5
Total	360.89	110,776	100.0	165.51	50,812	100.0

GRAZING MANAGEMENT (cont'd)

The amount of herbage consumed or otherwise removed, as measured by the difference between the A and B plots, is shown in table 2.

Table 2. Amount of herbage produced, amount remaining after grazing, and forage consumed or lost in 160-acre pasture.

	Black grama (pounds)	Other grasses (pounds)	Total (pounds)
Total inventory before grazing	68,928	41,848	110,776
Herbage remaining after grazing	29,720	21,092	50,812
Forage removed	39,208	20,756	59,964
Utilization (percent)	56.9	49.2	54.1

The proper utilization of black grama is given as from 50 to 55 percent of the total volume of the plant by weight. It will be seen from the above chart that the grama was slightly overutilized while the utilization of "Other Grasses," consisting mostly of dropseed, is proportionally lower which is as it should be owing to its lesser palatability. As a matter of fact, it is doubtful if little or any of the dropseed grasses were grazed. A high percentage of volume taken was found to be loss from weathering, trampling, and from rodent damage. A better balance of use would have been obtained between the grama and dropseed had the stocking been extended over a much longer period to allow for the early growth of the dropseed which would have resulted in heavier use of this forage.

COOPERATING BUREAU PROJECTS

BIOLOGY

(In cooperation with the Bureau of Biological Survey)

Lake States

Food Habits of Chipmunks. The stomachs and cheek pouches of a number of chipmunks were analyzed during the 1938 and 1939 field season to determine their food habits.

The food habits of these animals, like many others, are influenced very largely by availability. However, a beneficial effect upon the forests is indicated by the high frequency of insects and insect eggs consumed by the rodents, which normally exceeds the bird population on an area.

Northeastern

Forest Wildlife Relationships formed the basis for a half day session during the Annual Advisory Council meeting December 15 and 16. A number of investigators in this field also attended to discuss their work, and questions were brought up by members of the council, including Prof. Ralph T. King, Dr. Neil Hosley, Dr. Robert Trippensee, Mr. B. C. Park (U.S.F.S.) and Mr. Clarence Aldous (U.S.B.S.). One of the suggestions brought out by Prof. King may hold considerable value. He advanced the idea that the economics of Forest Wildlife should be investigated thoroughly providing a basis for justifying more extensive research programs.

The relation of forest cover to earthworms has become a pivotal point in the cover control practices on Moosehorn Migratory Bird Refuge, Washington Co., Maine. The refuge lies in the heart of important woodcock nesting grounds and was established primarily for the management of this species. Problems facing the refuge manager center about maintaining large areas of hardwoods in relatively young age classes preferred by woodcock and reducing the percentage of spruce and fir in these stands to a minimum since they create soil conditions unfavorable to earthworms. It has been found that such worms form 80% of the woodcock's diet while on refuge.

ENTOMOLOGY

(In cooperation with the Bureau of Entomology and Plant Quarantine)

Northeastern

Low temperatures in fall cause high gypsy moth egg mortality. During the winter of 1938-39 field studies were made on the influence of low winter temperatures on the mortality of gypsy moth eggs. The egg clusters used in these studies were collected in Bartlett, N. H., about the first of October and approximately 30 egg clusters were mounted on each of 12 boards. Six of the boards were hung in a weather instrument shelter located at Bartlett, N. H. and the other six in a similar shelter at Gale River, N. H. One board was removed

from each shelter on the last day of each month from November through April. On removal the egg clusters were isolated in small boxes, placed in a heated room, and later examined to determine the number of larvae that hatched from the different lots. The average hatch per cluster for the different lots and the minimum temperature for the month are given in the table below:

Month	Bartlett, N. H.		Gale River, N. H.	
	Min. temp.	Aver. hatch per cluster	Min. temp.	Aver. hatch per cluster
Nov.	-10	310 \pm 24.4*	-20	0
Dec.	-11.5	262 \pm 25.2	-11	0
Jan.	-20	2 \pm 1.1	-28	0
Feb.	-12	3 \pm 1.2	-15	0
Mar.		7 \pm 2.2	-18	0
Apr.		7 \pm 2.3	0	0

*Standard errors are used in preference to probable errors.

A temperature of -20 in November was sufficient to kill all of the eggs, while a few survived at this temperature in January. This indicates a conditioning of the eggs to cold, and that eggs can withstand lower temperatures in January than in November. It is significant that there was no increase in mortality after the last of January. This study was made possible through the cooperation of the staff of the Experimental Forests of the Northeastern Forest Experiment Station located at Bartlett and Gale River.

Southern

Christian's preliminary reports on his experiments at Tallulah, La., appeared in the December 15, 1939, issue of the Southern Lumberman under the titles: "Experiments on the prevention of ambrosia beetle damage in hardwoods," pp. 110-112, and "Chemical dip tests against *Lyctus* powder-post beetles," pp. 105-109. Experiments with *Lyctus* adults reared in the constant temperature chamber are being continued; the parasite *Monollexis lycti* can complete its life cycle in one month.

Johnston, at Saucier, Miss., is continuing his biological studies of ambrosia beetles, particularly noting activity during the winter under natural and artificial conditions.

Johnston assisted Wirka of the Forest Products Laboratory examining cooperative wood-preservative tests on the Harrison Experimental Forest the week of January 29th.

January 29-31 was spent by Snyder at Louisiana State University, Baton Rouge, La., participating in the pest control clinic, held in cooperation with the National Pest Control Association.

The Eleventh progress report on the international termite exposure tests was published by the American Wood Preservers' Association in January; the data on other tests have been tabulated to date on 5 x 8 cards.

PATHOLOGY

(In Cooperation with the Bureau of Plant Industry)

Appalachian

Plantation Examinations. A report was issued on the results of the examination of 20 southern pine plantations between 9 and 50 years old in North and South Carolina, and several younger plantations. The purpose of the survey was to obtain some information on diseases to be expected in older southern pine plantations. Although no conclusions can be drawn from so small and heterogeneous a sample, involving 4 species, many spacings, soil types, etc., it appeared that the only disease likely to prove seriously detrimental to these species is the rust canker. Some slash pine plantations had more than half of the trees deformed, reduced to mere bushes, or killed by this disease. Other slash plantations were almost free from the canker.

Service to the CCC. Illustrated talks on tree diseases were given at 4 CCC camps on the Pisgah National Forest and 3 on the Nantahala. Many areas within these forests were examined to see where sprout clump reduction or pruning could be done to decrease later losses from decay. These areas were reported in a memorandum on the visit sent to the Regional Forester and the Supervisor. A demonstration area on sprout clump reduction was established at Bent Creek for the use of the Pisgah National Forest.

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Gray, L. G., and
Funk, I. C.

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Influence of forest cover on wind velocity. (For Jour. of For.)

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Forest Genetics: Present status and future aspects. (For Proceedings of the Pacific Science Congress.)

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Problems of Forestation Research. 1940.

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Sump, A. W.

Successful direct seeding of northern conifers on shallow-water-table areas. (For Jour. of For.)

Stoeckeler, J. H. Watering in the nursery. (For Plains Forester)

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Duffield, J. W. Time savers for fixing and dehydration accepted by Stain Technology.

Jensen, V. S. Cost of Producing White Pine Lumber in New England. (For publication U. S. D. A. Circular.) (Behre, Benson and Jensen).

Snow, A. G., Jr., and
Duffield, J. W. Genetics in Forestry. (For Jour. of For.)

Stickel, Paul W. An Automatic Instrument for Detecting and Reporting Forest Fire. (For Fire Control Notes.)

The Technical Basis for Closing the Woods During Dangerous Periods of Forest-Fire Weather, (For "Hunting and Fishing")

Pacific Northwest

Briegleb, P. A. First-season results of Dowax treatment of Douglas fir planting stock at Wind River, Jan. 1940.

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